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NEW PHILIPPINE ZYGOPINÆ, CALANDRINÆ, AND CRYPTODERMINÆ (CURCULIONIDÆ, COLEOPTERA)

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ONE PLATE

Thanks to the collecting activity of Prof. Charles Fuller Baker, of Los Baños, I am able to give in this paper an essential contribution to the knowledge of the Zygopinæ, Calandrinæ, and Cryptoderminæ, subfamilies which have hitherto been given but little attention. I also acknowledge the kindness of Mr. W. Schultze, of Manila, to whom I am indebted for some interesting new species.

The new species and forms described are the following:

ZYGOPINÆ

- Chirozetes lineolatus* sp. nov.
- Achirozetes kleinei* g. et sp. nov.
- Microzetes trochilus* g. et sp. nov.
- Mecopus coelestis* sp. nov.
- Phylaitis vidua* sp. nov.
- Calophylaitis principalis* g. et sp. nov.
- Metialma rufirostris philippinica* subsp. nov.
- Metialma straminea* sp. nov.
- Metialma laquearis* sp. nov.
- Nauphaeus decoratus* sp. nov.

CALANDRINÆ

- Otidognathus pictus nigricollis* subsp. nov.
- Omotennus sanguinosus x-rufum* subsp. nov.
- Ommatolampus schultzei* sp. nov.

CALANDRINÆ—Continued

- Ommatolampus sulcirostris* sp. nov.
- Anathymus nigroscutellatus* sp. nov.
- Prodiocetes surigaonis* sp. nov.
- Prodiocetes surigaonis* var. *nigripennis* var. nov.
- Prodiocetes unicolor* sp. nov.
- Sphenocorynus femoratus* sp. nov.
- Tetratopus scabrirostris* sp. nov.
- Periphemus albomaculatus* sp. nov.
- Diasthetus crassiusculus* sp. nov.
- Poteriophorus regulus* sp. nov.
- Cercidocerus sanguinipes* sp. nov.
- Pseudacanthorrhinus bipodex* g. et sp. nov.
- Sphenophorus nigrovittatus* sp. nov.
- Laogenia cylindricollis* sp. nov.

CRYPTODERMINÆ

- Cryptoderma longicollis* sp. nov.
- Cryptoderma mangyanum* sp. nov.

ZYGOPINÆ

Chirozetes lineolatus sp. nov., ♀. Plate 1, fig. 1.

Niger, prothorace coriario, transverso, lineis tribus, tenuibus, scutello, elytris sutura spatiisque 1. ad 6. basi, lineola in spatiis 1. ad 3. et 5. atomisque, seriatis, in striis, punctato-striatis, lateralibus, ut corpore subter, in meta-episternorum dimidia parte apicali, abdomine utrinque macula nigro-denudata, basali, excepta, et tarsis albo-tomentosis; rostro apice subrufescenti, in dimidia parte basali striato-punctato; elytris spatio secundo adjacentibus latiore ac subconvexiore, irregulariter biseriato, tertio-quinto in dimidia parte basali, sutura tota uniseriato-granulosis; pedibus subrufescentibus, parce griseo, tibiis apice nigro-pilosis. Long. 6, lat. 2.2 mm.

MINDANAO, Zamboanga Province, Dapitan (Baker 14524).

Form of elytra short trigonate as in *Daedania* Pascoe,¹ but the anterior femora slender as in *Chirozetes*. Brownish black, with the following white design: Three fine lines above on thorax, spare atoms at its sides, a basal band extending on each side to sixth stria and a short line behind middle of first, third, and fifth intervals of elytra, suture and scutellum entirely, met-episterna in posterior half, abdomen except a black patch on each side of base and tarsi white tomentose. Apical part of tibiæ black hairy.

Genus **ACHIROZETES** novum

Zygopinorum prope *Chirozetes* Pascoe. Antennae funiculo sex-articulato, clava articulorum linea separationis undulata. Femora valida, antica denticulis tres, primo longiore, postica dente trigono, magno, huius margine postico serrato-dentato. Tibiæ posticae valde arcuatae. Scutellum subquadratum, margine postico subbilobato.

The principal characters distinguishing this new genus from *Chirozetes* Pascoe are the stout, basally slightly attenuate femora with a large, trigonate, serrate, and denticulate tooth which is serrate on the posterior margin, and the strongly curvate posterior tibiæ. Besides the species described herein *Chirozetes validipes* Heller² belongs to *Achirozetes*.

Achirozetes kleinei sp. nov. Plate 1, fig. 2.

Niger, capite, prosterno, prothorace basi lineisque tribus, lateralibus bi-interruptis, scutello, elytris sutura in triente

¹ Ann. & Mag. Nat. Hist. IV 7 (1871) pl. 15, fig. 1.

² Tijdschr. voor Ent. 37 (1894) 33, pl. 2, figs. 1 and 1a.

basali, spatio primo toto, spatio quarto quintoque basi exigue, hoc ante medium praeterea lineola ac in secundo triente macula, spatio sexto communi, punctiforme, ut corpore subter, pallide lutescenti-squamosis; rostro in parte apicali sat nitido ac subtiliter, reliquo opaco ac crebrius punctato; prothorace coriario, longitudine vix latiore; elytris striis punctato-striatis, bene definitis, sutura in dimidia parte apicali, spatio secundo, reliquis latiore, ut tertio quintoque remote seriato-granulatis. Long. 6, lat. 2.2 mm.

MINDANAO, Zamboanga Province, Dapitan (Baker).

Very similar to *Achirozetes validipes* and congeneric with it, but the prothorax without a middle carina and with a tolerably broad luteous basal band bent forward on each side. Suture in the first third, first interval entirely, a short line before the middle of fifth interval and a common spot in the second third of fifth and sixth intervals pale yellowish.

This species is interesting from the viewpoint of geographic distribution (the next related species is Papuan) and is dedicated to my friend Mr. R. Kleine, of Stettin, a very meritorious entomologist.

Genus MICROZETES novum

Zygopinarum prope *Chirozetes* Pascoe. Rostrum thoracis longitudine vix aequale, apice depressum. Antennae funiculo sex-articulato, clavam breviter ovatam versus sensim incrassato, articulis 3. ad 6. fortiter transversis. Prothorax transversus, spina prosternali utrinque armatus. Elytra brevia (latitudine e. sexta parte longiora) apice singula rotundata, sutura in dimidia parte basali impressa. Coxae anticae separatae. Sternum abdominale, secundum, duobus sequentibus unitis aequilongum. Femora sat brevia, haud clavata, postica elytris tertia parte superantia, extus subcarinulata, antica dente, obtuso, armata. Tarsi postici (ut in genere *Chirozetes*) articulo primo reliquis unitis aequali, antici, maris, subtilissime fimbriati.

Differs from *Chirozetes* Pascoe chiefly by the very short, apically separately rounded elytra, the suture being impressed in the basal half by the funicle of antennae which is thickened gradually in such manner that it passes over into the short ovate club, and by the sublinear femora the posterior of which show an indistinct carinula along the outside.

Microzetes trochilus sp. nov., ♂. Plate 1, figs. 3 and 3a.

Fuscescenti-niger, squamulis cervinis, partim setiformibus ac albidis tectus; rostro usque ad apicem depressiusculum, fortiter,

in dimidia parte basali seriato-punctato ac hic praeterea quinque-carinulato; antennis subrufescentibus funiculo articulis 2. ad 6. longitudine plus duplo crassiore, articulo 6. clava adpresso, hac crassitudine duplo longiore, subelliptica; prothorace transverso, spinis prosternalibus brevibus armato, crebre subrugoso-punctato, punctis squamulis cervinis, setiformibus, transverse directis, alteris maioribus, ellipticis, in maculis tribus basalibus et ad latera condensatis, munitis; scutello glabro, punctiforme; elytris maxima latitudine post humeros, prothorace latioribus, punctato-striatis, puncto singulo squamula, setiforme, cervina, repleto, spatiis minute seriato-granulatis, primo fere usque ad medium tres sequentibus (exterioribus) in circuitu minore albido-variegatis; corpore subter lutescenti, partim albido-squamoso, squamulis praesertim in metasterni lateribus magnis, longitudinaliter subimpressis. Long. 3, lat. 1.5. mm.

MINDANAO, Zamboanga Province, Dapitan (*Baker*).

In form somewhat similar to a small *Metialma* species, but in other respects nearly related to *Chirozetes*. Dark brown, covered with fawn-colored, partly white, setiform scales. Rostrum strongly punctate to apex, in the basal half with fine carinulae. Prothorax covered sparingly with transversely directed, setiform, fawn-colored scales and larger, elliptic ones, the latter forming three densely squamose basal patches. Elytra broadest behind the shoulders, broader than the thorax, punctate-striate, each puncture filled with a more saturate fawn-colored bristle-like scale, intervals finely and remotely seriate granulate, the four inner varied with white in such manner that there is formed an indistinct triangular whitish area, reaching to the middle of the suture and on each side as far as to the fifth stria.

Mecopus coelestis sp. nov., ♀.

M. spinicollis Pascoe affinis, sed prothorace lateribus ante medium antrorsum rotundato-convergentibus, apice minus abrupte coarctato; elytris plus elongatis ac attenuatis; femoribus posticis multo longioribus, signaturis squamosis similiter dispositis, sed cobaltinis; rostro brevior, minus distincte carinulato; antennis funiculo tenuiore, clava plus elongata; prothorace rugoso-granulato, carina dorsali ante abbreviata, manifesta; scutello oblongo, nigro-velutino; elytris dorso depressis, spatiis, ab stria quarta, carinatis ac sat remote aspere granulatis; femoribus posticis dimidia parte elytris prominentibus, tibiis posticis medio fortiter incrassatis, tarsis omnibus articulo primo secun-

doque supra, corpore subter fere toto, cobaltino-squamosis, macula communi laterali in metasterno episternisque, in elytris oblique continuata, nigra, excepta. Long. 12, lat. 5.3, long. femor. post. 7.5 mm.

MINDANAO, Agusan Province, Butuan (*Baker*).

Very closely allied to *M. spinicollis* Pascoe from Java, but distinguished by the much longer club of antennæ, the form of prothorax, the sides of which are slightly rounded and convergent in the apical half, the much longer posterior femora, the strongly thickened hind tibiæ, and the pale blue instead of ashy squamosity.

Phylaitis vidua sp. nov. Plate 1, fig. 4.

Aterrima, prothorace linea mediana angulisque posticis, scutello, vittiforme, elytris sutura in primo triente maculaque utrinque anteapicali, subquadrata ac subdentata atomisque numerosis ad suturam, secundum strias elytrorumque ad apicem, ut corpore subter, albo-squamosis; rostro prothorace paulo longiore, dimidia basali quinque-subcarinulato ac punctato-striato; antennis subrufescentibus, funiculo articulo secundo primo, tertio sua crassitudine paulo longioribus, sequentibus inter se fere aequalibus; prothorace transverso, dense subgranuloso-punctato; elytris prothorace vix latioribus, striis punctatis, in triente apicali evanescentibus, sutura post medium manifeste elevata, ut spatii 2. ad 4. remote uni-seriato-granulosis, spatio quinto basi deprimato; femoribus anticis subfusiformibus, posticis dente magno, trigono, armatis; corpore subter, praesertim in prosterno, squamulis maioribus, breviter ellipticis, tecto. Long. 4.5, lat. 1.8 mm.

MINDANAO, Zamboanga Province, Dapitan (*Baker 14523*).

In consequence of the contiguous anterior coxæ, comparatively short anterior subfusiform femora, short third joint of antennæ, and large triangular tooth of posterior femora, this species belongs to *Phylaitis* in spite of its similarity to a *Mecopus* female. Color black, with the following markings: Posterior angles and the middle line of prothorax, scutellum (which is twice as long as broad) entirely, the first third of suture densely, the remaining elevated part sparingly (and more setose), a subapical patch bidentate in front and behind on each side of elytra, extending from first to fourth stria, numerous seriate atoms, along the striæ, and in the apical part white squamose. Underside wholly and densely white squamose, the somewhat reddish legs more sparingly white setose.

Genus *CALOPHYLAITIS* novum

Zygopinarum. Rostrum robustum, prothorace vix longius, basi sectione transversa subpentagonali, dorso quinque subcarnulatum ac striato-punctatum. Antennae rostri apice quam medio propiore insertae, funiculo sex-articulato, apicem versus sensim incrassato. Prothorax basi truncatus, lobis ocularibus nullis. Scutellum magnum, subquadrato-rotundatum. Elytra fere conica, apice rotundato-truncata, decem-striatis. Mesepimera angusta, etsi adscendentia. Sternitum abdominale secundum tertio vix longius. Coxae anticae separatae. Femora dentata, postica elytra haud superantia. Tibiae haud curvatae.

The comparatively stout rostrum and the short second ventral segment separate this genus from all other genera of *Zygopini* without ocular lobes and with six-jointed funicle. Its form is similar to *Phylaitis* near which it may be placed.

Calophylaitis principalis sp. nov.

Nigra, supra squamulis plus minusve setiformibus, subter squamis sat magnis tecta, capite post oculos thoraceque, margine basali anguste albido excepto, cinnabarino-squamosis, vertice minute granulato; elytris sat tenuiter profundeque subpunctato-striatis, fascia basali, ut scutello, griseo-, fascia mediana, arcuata (post concava) guttaque suturali, apicali, stria secunda determinata, niveo-squamosis. Long. 4, lat. 1.5 mm.

MINDANAO, Agusan Province, Butuan (*Baker*).

The cinnabar-red thorax and the black elytra with a median white arcuate crossband make this species easily recognizable. The margin of the eye is slightly angulate below (not perfectly rounded), the antennae are inserted nearer to the apex than to the middle of rostrum, the funicle is densely white setose, the club black. Scutellum subquadrate, extending on each side to the first elytral stria and like the intervals of elytra with a fine granulation, ordinarily hidden by the squamosity.

Metialma rufirostris ³ *philippinica* subsp. nov.

Differt a specie typica: Statura minore, femoribus posticis longioribus, sternito anali, maris, ultimo utrinque longius laciniato-producto, corpore subter squamulis, praesertim metasterni in lateribus acute lanceolatis (in sp. typica ellipticis) ac longitudinaliter subimpressis. Long. 2.1 ad 2.5, lat. 1.2 ad 1.4 mm.

LUZON, Laguna Province, Los Baños, Mount Maquiling: Tayabas Province, Malinao (*Baker*).

³ Faust, Stettiner Ent. Zeitg. 44 (1883) 482.

As in Faust's *M. rufirostris*, described from a single specimen from Burma, the new subspecies has the apical half of rostrum, the antennæ, and the tarsi ferrugineous and the squamosity with the same pattern and color. The only differences, besides the much smaller size (2.1 to 2.5 millimeters as opposed to 3) are: The laterally longer produced anal segment of male, the longer acute lanceolate (instead of elliptic) scales, especially on the sides of metasternum, which are impressed, and the longer posterior femora.

Metialma straminea sp. nov., ♂, ♀.

Niger, annis, totis, tarsisque apice, ferrugineis, supra sat dense stramineo-tomentosa, prothorace disco macula transversa aut gemina, rare deficiente nigricante, elytris parce nigricante-variegatis; prothorace angulis posticis margineque, postico, ante scutellum, scutello, ut corpore subter, albo-squamosis, sternito abdominali tertio quartoque medio utrinque nigro-maculatis, sternito anali, maris, utrinque albo-laciniato. Long. 4.5, lat. 3 mm.

LUZON, Laguna Province, Los Baños, Mount Maquiling (2632); Mount Banahao (*Baker*).

Black, antennæ and tarsi, especially the last joint, ferruginous; upper side covered all over with a hairy straw-colored tomentum, a little black mottled on the elytra; prothorax with a transverse, blackish discal patch, sometimes divided, or wanting, sometimes also a small one of the same color on the anterior angles, then a dot on the posterior angles and on the scutellar lobe, the whole scutellum, apex of suture, and underside of body pure white, a black dot on each side of the middle line of third and fourth ventral segments excepted.

Metialma laquearis sp. nov., ♂, ♀.

Nigra, annis, clava nigra excepta tarsisque apice nigris, parce, sutura apice densius albido-setosa, plagis prothoracalibus ut punctis variegatim dispositis in elytris, nigro-denudatis; prothorace maculis duabus discoidalibus approximatis (aut subconvexis), alterisque utrinque basalibus, minoribus, conjunctis denudato-nigris, extrinsecus vitta, albida, medio constricta, aut interrupta, determinata usitatim basi apiceque laqueato-dilata, maculam rotundatum ad marginem apicalem et basalem circumcingente; pygidio maris carinato, utrinque plus minusve, rare toto, corpore subter omnino albido-tomentoso, meta-episternis interdum nigricantibus. Long. 4 ad 4.5, lat. 2 ad 2.4 mm.

LUZON, Laguna Province, Mount Maquiling, Los Baños (613) : Tayabas Province, Malinao. MINDANAO, Zamboanga Province, Dapitan (Baker).

A black, whitish tomentose species, variegate on elytra, with reddish antennæ and black club. The whitish fine lateral vitta on prothorax in front and at the base usually similarly dilated. Pygidium of male carinate, anal sternite on the apex impressed, hardly produced on each side.

Key to the Philippine species of the genus *Metialma* Pascoe.

a¹. Rostrum ferruginous on the apical half.

b¹. Tibiæ blackish.

c¹. Upper side with unicolorous yellowish tomentum.

M. obsoleta Heller.

c². Upper side with creamy dots, three on base of prothorax, and one on apex of suture. Length at most 2.5 millimeters.

M. rufirostris philippinica subsp. nov.

b². Tibiæ and tarsi yellowish red, elytra with a broad cretaceous sutural stripe extending to third stria and dilated gradually toward base to fifth stria..... *M. gilvipes* Heller.

a². Rostrum at most dark red at apex.

b¹. Antennæ with club black, the rest ferruginous.

c¹. Pygidium on each side or entirely covered with whitish, carinate in male..... *M. laquearis* sp. nov.

c². Pygidium black, in the male without a median carina, but in this sex on the first ventral segment with a transverse, denser, and yellowish tomentose patch in the middle..... *M. nigritana* in litt.

b². Antennæ entirely red.

c¹. Pygidium, metepisterna, and abdomen unicolorous, covered with whitish tomentum..... *M. straminea* sp. nov.

c². Pygidium entirely black or only on the apical half; metepisterna in the anterior part, the third and fourth ventral segments on each side of the middle line with a more or less distinct black spot. Java. MINDANAO, Surigao Province, Surigao; Lanao Province, Kolambugan; Agusan Province, Butuan (Baker 4508). LEYTE, Tacloban (Baker 15029)..... *M. ignorata* Faust.⁴

Nauphaeus decoratus ⁵ sp. nov.

Niger, opacus, antennis subsanguineis, prothorace subirregulariter punctato, disco subfuscescenti, lineis isabellinis, tenuibus, his ornatus: in prothorace utrinque duabus longitudinalibus,

⁴ Stettiner Ent. Zeitg. 44 (1883) 483.

⁵ The sixth Philippine species of this genus; the others are *simius* Faust, Mindanao, Kolambugan (14673); *linearis* Heller, Stettiner Ent. Zeitg. (1908) 179, Borneo, Luzon, Laguna Province, Magdalena (1751); *sexmaculatus* Heller, Philip. Journ. Sci. § D 8 (1913) 146; *manobo* Heller, Philip. Journ. Sci. 19 (1921) 620, Mindanao, Zamboanga (7318, 7319); and *carbonarius* Heller, op. cit. p. 619, Luzon, Tayabas Province, Malinao (Baker).

basi conjunctis ac remotis, medium versus valde approximatis, dein apicem versus divergentibus, linea interiore prothoracis marginem anteriorem attingente, exteriori post sulcum latero-apicalem deorsum curvata ac coxis anticis attingente; in elytris, minute parceque granulatis spatiorum secundo reliquis convexiore ac latiore, una baseo-marginali, altera baseo-submarginali, utrinque ad humeros atque ad scutellum conjunctis, area transversa dorso-basali majore, altera infrahumerali minore cingentibus, linea mediana, transversa, undulata, ad suturam et ad striam quintam breviter antrorsum inflexa, extus utrinque anulis duabus minutis, interdum obsoletis, conjunctis, deinde linea circulari laterali antè secundum trientem, inter striam septimam et nonam, altera inter primam et quartam, ante declivitatem, post lineis duabus parallelis, marginem apicalem attingentibus, exmitentibus; corpore subter albido, metasterno sternitisque 1° ad 4° lateribus, plus minusve roseo-, sternito abdominali secundo utrinque medio, tertio quartoque fere totis, nigricanti-, sternito anali femoribusque cinereo-squamosis. Long. 10.5, lat. 4.9 mm.

MINDANAO, Agusan Province, Butuan (*Baker 18740*).

A dull black species, very similar in size and form to the other species of the genus but the elytra and the shoulders a little broader than the base of prothorax, both ornamented with delicate ochreous lines: Two on each side along the disk of prothorax, very approximate in the middle and diverging toward the base and apex, two transverse lines at the base of elytra, confluent on the shoulders, one transverse undulate line near the middle, between the suture and the fifth stria, and two circular lines, one at the sides before the second third and between the seventh and ninth striae, the other on the declivity, between the first and fourth striae, sending out posteriorly two parallel lines toward the apical margin.

CALANDRINÆ

Otidognathus pictus ⁶ *nigricollis* subsp. nov.*

Niger, elytris ferrugineis, limbo suturali tenui, macula utrinque subapicali margineque apicali (fere ut in *picto*) in sutura spatiorum primo producta, nigris; metasterno lateribus, meso-sternis, meso-epimeris meta-episternisque singulis macula mediana, rufa; rostro, maris, longitudinaliter ruguloso, haud seriatim tuberculoso. Long. 14, lat. 6.8 mm.

* Philip. Journ. Sci. 19 (1921) 623, pl. 3, fig. 10.

LUZON, Ilocos Norte Province, Burgos (*Schultze*).

Several specimens strikingly uniform in color coming from Ilocos Norte seem to be only a local race of *O. pictus* Heller, differing from this species by the entirely black prothorax and pygidium and the reddish elytra, each of which bears only a black subapical spot and a common apical band, similar to that of *O. pictus*, produced on the suture and first interval. Sides of body bare (perhaps the golden yellow velvet is worn off).

Omotemnus sanguinosus. x-rufum subsp. nov., ♂.

Differt a specie typica: prothorace utrinque vitta, basi apiceque abbreviata, antrorsum attenuata; elytris fascia postmediana, rubra, in similitudinem x. litterae ad suturam antrorsum, dein ad marginem lateralem extrorsum, currente. Long. 20, lat. 8.2 mm.

MINDANAO, Lanao Province, Iligan (*Baker*).

The typical specimen is a female from Mount Maquiling, Luzon; the male described here, from Iligan, Mindanao, has a similar but shorter rostrum, a shorter, laterally more-rounded prothorax, and a shorter more-obtuse pygidium; moreover, the prothorax shows a black vittiform patch on each side of the disk and the postmedian red part of elytra is extended in front along the suture, running thence toward the subhumeral patch, forming in this manner a red x-shaped figure. Since both specimens are unique, it is impossible to say whether the described form is a local race or a variety.

Ommatolampus schultzei sp. nov., ♀. Plate 1, fig. 5.

O. haemorrhoidali Wied. statura similis, pygidio, apice haud impresso, ut corpore reliquo, maxima parte nigris, maculis sanguineis his ornatus: prothorace utrinque post medium gutta, interdum deficiente, elytris macula antehumerali, transversa, vitta obliqua (e maculis oblongis duabus, subconvexis, formata) spatii primi in primo quarto incipiente ac marginem lateralem versus ad sternitum primum ventralem currente, macula subapicali inter striam tertiam et quartam, corpore subter maculis minoribus, una utrinque in prosterno, una laterali in mesosterno, una, transversa, mediana, in mesepimeris et una subapicali in meta-episternis; ♀ pygidio apice haud impresso. Long. 29, lat. 8.5 mm.

LUZON, Nueva Ecija Province, Caraballo Mountains (*Schultze*).

Rostrum, in comparison with *O. haemorrhoidalis* Wied., shorter, and higher in vertical extension, the apex transversely

subrectangularly excised. Elytra broader than in the above-mentioned species, with striae 3 and 4 approximate at the base; striae hardly punctate, a transverse patch before the shoulder, an oblique band beginning in the first quarter of second stria, running on the lateral margin to the first ventral segment, and a subquadrate, subapical patch between the third and eighth striae, red; of the same color are a spot on each side of prosternum, on the sides of metasternum, on mesoepimera and metepisterna, the latter of which is subapical. First ventral segment behind the posterior coxae with a submarginal stria, touching the met-episterna exteriorly.

Ommatolampus sulcirostris sp. nov., ♂. Plate 1, fig. 6.

O. parastasiodi Heller¹ affinis, supra sanguineus, plaga utrinque oblonga thoracali, elytris fascia basali, margine postico, dentato, ad suturam perpendiculari, scutello maculaque postscutellari, fascia mediana, paulo transversa, inter striam tertiam et marginem lateralem, margine apicali, inter stria tertiam utrinque antrorsum dilatata, pygidio, apice impresso, macula utrinque, rufa, basali excepta, ut corpore subter, prosterno, sternito anali, femoribus tibiisque rufis exceptis, nigris; rostro dorso linea tenui impressa, sternito abdominali primo sulco postcoxali via indicato. Long. 30, lat. 9 mm.

MINDANAO, Surigao Province, Surigao (*Schultze*).

Similar to *O. parastasiodes* Heller but rostrum dorsally with a fine impressed line, elytra with a black basal band, the denticulate posterior margin of which is perpendicular to the suture, as is the anterior margin of the subquadrate medial patch. Pygidium black, a basal spot on each side red. First ventral segment with a barely indicated postcoxal line.

Anathymus nigroscutellatus sp. nov., ♀. Plate 1, fig. 7.

Niger, prothorace, fortiter punctato, vittis tribus, nigris, exceptis, elytris in sutura, spatio primo secundoque vitta, basin versus usque ad striam quartam dilatata, macula mediana, oblongo-elliptica, inter striam quintam nonamque, pygidio pedibusque, genubus tarsisque, nigris, exceptis, rufis; pygidio lateribus vitta marginali, corpore subter maxima parte, albu-pruinosis; femoribus posticis (in ♀!) sterniti anali dimidium superantibus. Long. 10.5, lat. 2.8 mm.

MINDANAO, Surigao Province, Surigao (*Baker*).

¹ Notes Leyden Mus. 18 (1897) 245.

In the genus *Anathymus* Pascoe,⁸ as in others, the male differs from the female by a strongly punctate rostrum which, in the latter, is nearly smooth, whereas in differentiating the species the form of the pygidium is an important character. In *A. singularis* Pascoe, this is simply convex lengthwise in the male; in *A. meyeri* Faust⁹ a little cristately produced beyond and above the apex in the male, simply convex in the female; in *A. coloratus* Faust, male, acutely conical, female, obtusely produced; in a hitherto undescribed Formosan species (*A. tricolor* Heller in litt.) it is similar in both sexes; in the female of *A. nigroscutellatus* sp. nov., but slightly produced above the apex. The color of the last-named species is black, underside whitish pruinose, prothorax strongly punctate, red except for three black vittæ; of the same color are a broad sutural stripe, dilated toward the base as far as the fifth stria, an oblong elliptic patch on each elytron between the fifth and ninth striæ, and the femora and tibiæ except at apex.

Prodiocetes surigaonis sp. nov., ♀. Plate 1, fig. 8.

P. rubrovittato Heller¹⁰ similis, sed rostro brevior, minus arcuato, prothorace vittis nigris tenuioribus, scutello nitido, elliptico, elytris spatiis alternatis (quarto quam tertio fere duplo) latoribus, stria 1. ad 4. punctato-striatis, tertia quarta valde approximata, 5. ad 7. seriato-punctis, sutura in dimidia parte apicali elevata, vittis nigris his ornatis: una suturali, suturam spatiumque primum, hunc basi apiceque exceptis, occupante, altera laterali, inter striam quintam et octavam, apice usque ad striam secundam introrsum curvata, tertia, marginali, extra striam nonam; praeterea pygidio lineola basali, mediana, sternito secundo, quartoque macula mediana, tertio quartoque praeterea altera, laterali, sternito anali lineola mediana, nigris; femoribus omnibus dentatis. Long. 9.5, lat. 3 mm.

MINDANAO, Surigao Province, Surigao (*Baker*).

Prodiocetes surigaonis var. *nigripennis* var. nov., ♂.

Differt a specie typica: elytris nigris, humeris rufomaculatis, abdomine haud nigro-maculato.

Apparently the two specimens before me, from the same locality, different in the color of the elytra, are the two sexes

⁸ Ann. Mus. Genova II 2 (1885) 299.

⁹ Stettiner Ent. Zeitg. 59 (1898) 207.

¹⁰ Philip. Journ. Sci. § D 10 (1915) 234.

of the same species. The male *P. rubrovittatus* Heller is somewhat similar in color to the female of *surigaonis* here described, but may be at once distinguished by the linear scutellum and by the very finely punctate rostrum which in *P. surigaonis* var. *nigripennis* is very strongly and densely somewhat rugulose punctate throughout. The principal difference between the species consists, however, in the very approximate third and fourth striae and the broad convex interval between the fifth and sixth striae. The typical specimen, a female, is red; three lines, a median line, two lines on the lateral margin of prothorax, a sutural, a latero-marginal and a submarginal stripe, between fifth and eighth striae, black; the latter stripe curved inward at the apex as far as to the second stria and not touching the humeral callosity. The variety *nigripennis* differs in having the black elytra with only a red humeral spot, and the abdomen not black maculate.

Prodiocetes unicolor sp. nov., ♂.

A *P. alternanti* Chevrolat aegre sed certe discernendus, unicolor rufus; rostrum (♂) tenuiore usque ad apicem crebre subruguloso-punctato; antennis funiculo tenuiore, articulo secundo crassitudine distincte longiore; prothorace disco subdeplanato; scutello minore; elytris in eodem modo quam in *alternanti*, spatio quarto convexo ac latiore; pygidio (♂) apice subbituberoso. Long. 11, lat. 4.5 mm.

MINDANAO, Surigao Province, Surigao (*Baker 14805*).

The long thin rostrum, which is as long as the prothorax, the finely and densely somewhat rugose punctate rostrum of the male, the disk of prothorax flattened in the basal half, and the uniform sanguineous color of the body are the chief characters for distinguishing this species from the similar *P. alternans* Chevrolat.

Sphenocorynus femoratus sp. nov., ♂, ♀.

T. feae Faust¹¹ sat affinis, unicolor sanguineus, subter albido-pruinosis, rostrum maris toto, feminae basi solum, rude punctato, prothorace dorso longitudinaliter depressiusculo, scutello nigro, oblongo-cordiforme, acuminato; elytris subtiliter punctato-striatis, stria 5. ad 9. striato-punctatis, stria decima (in generis specie typica, *sericans*, in triente basali explicata) tota oblitterata, spatio secundo adjacentibus vix, quarto his multo

¹¹Ann. Mus. Genova 34 (1894) 332.

lterioribus ac convexiore; pygidio latitudine basali longiore, mesosterno lobo intercoxali fere quadrato, margine postico medio anguste profundeque exciso, epimeris, episternis posticis metasternoque sat remote ubique punctatis, hoc praetera utrinque sulco, coxis intermediis post circumcingente, femoribus, apice nigris, posticis sterniti anali apicem attingente. Long. 15, lat. 5.2 mm.

MINDANAO, Surigao Province, Surigao (*Baker*).

This species differs from the typical species of the genus by the longer and more deeply notched intercoxal process of the mesosternum; the more finely striate, smaller, and less-depressed elytra; the longer pygidium; and the longer posterior femora. Color sanguineous, only the small cordiform acuminate scutellum and the tips of femora black. The inner four striæ of elytra punctate-striate, the others seriate, partly indistinctly punctate, interval between fourth and fifth striæ broadest and convex. Posterior femora attaining the apex of anal segment.

Tetratopus scabrirostris sp. nov., ♂, ♀.

Oblongus, rufus, supra linea mediana prothoracali scutelloque, subtus, margine antico lato prosternali excepto, lateribus femoribusque apice plus minusve nigris; *T. feae* Faust¹² similis, sed rostro paulo longiore ac crassiore in dimidia parte apicali minus attenuato, maris per totam longitudinem aspero-ruguloso, feminae perrude, apicem versus paulo subtilius punctato; antennis nigris, articulis 3 ad 6 longitudine duplo lterioribus, clava latitudine duplo longiore, basi subpedunculato-attenuata; prothorace latitudine longiore (3.7:4.5), margine laterali in dimidia parte basali subconcavo; scutello ovato (in *feae* trigono); elytris apice singulis rotundatis; pygidio rude punctato, maris apice truncato aut subbituberculato; mesosterno intercoxas intermedias bilobato; sternito ventrali primo medio (maris subconcavo) rude crebreque punctato. Long. 12, lat. 3.8 mm.

MINDANAO, Agusan Province, Butuan (19511).

Tetratopus scabrirostris ab. monomorphus ab. nov.

Maior, long. 13, lat. 4 mm., unicolor rufo-ferrugineus. (19512, 19509).

The smaller species of the genus *Tetratopus* (less than 16 millimeters long) can be distinguished as follows:

*a*¹. Intercoxal process of mesosternum sinuate, first ventral segment finely and remotely punctate, club of antennæ but little longer than broad.

¹² Ann. Mus. Genova II 14 (34) (1894) 332.

- b*¹. Sides of first and second ventral segments somewhat irregularly and remotely punctate, elytra black; length, 10 millimeters. (Pegu.)
T. semiruber Faust.¹²
- b*². Sides of first and second ventral segments equally and rather densely punctate, elytra red with few black spots. (Burma.) *T. feae* Faust.
- a*². Intercoxal process of mesosternum bilobate.
- b*³. Metasternum strongly but remotely punctate, anteriorly with a deep acute angularly produced postcoxal furrow, first ventral segment with few remote punctures..... *T. femoralis* Heller.
- b*². Metasternum finely punctate, without a deep postcoxal furrow, first ventral segment coarsely and densely punctate.
- c*¹. Middle line of prothorax and sides of body more or less black. (Mindanao.)..... *T. scabrirostris* sp. nov.
- c*². The whole body, except the blackish episternal suture of metasternum, brick red. (Mindanao.)
T. scabrirostris ab. *monomorphus* ab. nov.

Periphemus albomaculatus sp. nov., ♂.

Niger, prothorace in angulis anticis posticisque, elytris utrinque spatio tertio basi, macula altera in suturae medio, transversa, usque ad striam tertiam extensa, pygidio, carinula mediana nigra, excepta, meta-episternis segmentisque abdominalibus tertio quartoque, albotomentosis; rostro paulo arcuato, prothorace brevior, sat remote punctato, dorso vitta mediana levi, fronte bicristata; funiculi articulo primo, subsphaerico, secundo, oblongo-conico, distincte brevior; prothorace subcylindrico, latitudine fere duplo longior, fortiter punctato, disco in medio carinula brevissima, scutello elongato, acuminato; elytris subcylindricis, latitudine vix duplo longioribus (3.6:6), sat fortiter punctato-striatis; pygidio carina, mediana, post compressa, ultra apicem producta. Long 6.5, lat. 1.8 mm.

MINDANAO, Surigao Province, Surigao (*Baker*).

A small black species, ornamented above with white spots. Rostrum slightly arcuate, moderately densely punctate, with a broad smooth dorsal stripe. Antennae dark reddish. Front with two anteriorly convex crests. Prothorax white spotted in each angle. Elytra at the base of third interval with a short stripe, a common, transverse sutural spot, extending as far as to the third stria; pygidium, except a median vitta, metasternum, and the third and fourth ventral segments cretaceous-tomentose.

Diasthetus crassiusculus sp. nov., ♂, ♀. Plate 1, figs. 11, 11a.

D. semivelutino Chevrolat affinis ac similiter convexus, sed antennarum clava latitudine longior (1.3:1.5), elytris sine

¹² Deutsche Ent. Zeitschr. (1898) 331.

plagis nigro-velutinis, spatiis convexioribus; corpore subter maris metasterno in dimidia parte posteriore area rude punctata ac breviter fulvo-setosa. Long. 13 ad 17, lat. 5.8 ad 7.5 mm.

MINDANAO, Zamboanga Province, Dapitan (*Baker*). Philippines [Luzon?] (*O. F. v. Möllendorff*).

Diasthetus semivelutinus Chevrolat, from New Caledonia, and *D. crassiusculus* sp. nov. are the only species of the genus with similarly convex elytra, but the latter has no velvet black patches on the elytra, at the base more-convex shining denudate intervals, a longer antennal club, and in the male the metasternum in the posterior half strongly punctate and set with short stiff hairs.

Poteriophorus regulus sp. nov., ♀. Plate 1, fig. 13.

Albus, prothorace latitudine paulo longiore (7.1:8 mm.), dorso vittis tribus, mediana latiore, lateribus maculis duabus, vittiformibus, inframarginali basi apiceque, supracoxali solum basi abbreviatis, nigris; scutello vittiformi, sulcato, albo, apice acuminato; elytris latitudine paulo sesqui longioribus (8.5:13 mm.), nigris, margine basali vittisque inter striam secundam tertiamque altera inter sextem et septimam, in elytrorum primo triente, in rami latioris modum, confluentibus, in secundo triente utrinque cruciatim dilata suturam marginemque lateralem attingente, sutura anguste, in triente apicali vix albidis; pygidio albo, vitta mediana nigra; corpore subter albo, macula, lata, ad suturam metaepisternalem, altera in sternitis abdominalibus 2. ad 4. communi, sublaterali, unica apicali in sternito anali, nigris; prothorace omnino (latera versus haud fortius) subtiliter remoteque, metaepisternis sternitoque anali lateribus crebrius punctatis, lineis sulcatis duabus postmedianis in metasterno remotius ac plus parallelis quam in *P. niveo-punctato*. Long. 23.5, lat. 8.5 mm.

POLILLO, unicum.

A fine species, characterized by the white and black design (shown in the figure) agreeing in form with *P. fuscovarius* Waterhouse and *P. bowringi* Waterhouse rather than with *P. niveus* Gyllh., the type of the genus. The single female before me has the rostrum as in the species mentioned, carinate before the antennal scrobes and sulcate along the middle of the swollen and pale velvet-clothed basal part. All the punctures of the body are, as in *bowringi*, of small size, without a circle, except the punctures on the black elytral spots. Scutellum elongate, white acuminate. Elytra deeply furrowed along base. Pygi-

dium sparingly punctate. Intercoxal process of mesosternum deeply and very acutely angularly incised on apex. Metasternum in posterior half medially with two remote and parallel, impressed lines. Metepisterna as in *bowringi*, abundantly punctate, along the anterior part of suture with a large black patch common to metasternum. Sides of abdomen with a broad black lateral stripe extending from the half of second over the base of fifth ventral segment.

Cercidocerus sanguinipes sp. nov., ♂.

C. fabrilis Gyllh. simillimus, sed differt maris antennarum clava multo minus transversa (paulo minus quam in *x-rufo* Chevrolat), funiculi articulo secundo plus transverso, prothorace minus elongato, disco concavo, carinula mediana, sat minute crebreque punctato, margine basali, extrorsum dilatate, scutelloque, vittiforme, albo-pruinosis; elytris subtilius punctato-striatis, plaga mediana rotundata nigro-velutina, maiore; femoribus sanguineis subclavato-incrassatis. Long. 11, lat. 5.4 mm.

MINDANAO, Davao Province, Davao (*Baker*).

Like *C. fabrilis* Gyllh., above black, with a black but larger and more-roundish black velvety patch in the middle of each elytron; the femora, except the black apex, red; club of antennæ much less transverse (in male) than in *C. fabrilis*, its breadth less than the length of scape; elytra more finely punctate-striate.

Genus PSEUDACANTHORRHINUS novum

Calandrinorum prope *Sphenocorynus* Schönherr. Rostrum breviusculum, apice subincrassatum ac paulo curvatum. Antennae clava asymmetrica, compressa, subtransversa, parte spongiosa, apicali, tenui, vittiforme. Scutellum lineare. Elytra oblongo-elliptica, dorso convexa, apice subtruncato-rotundatis. Pygidium transversum. Femora mutica, antica brevia, validiuscula. Tibiae posticae longitudinaliter carinulatae. Mesosternum lobo intercoxali subquadrato, ultra coxarum intermediarum centrum producto. Sternita abdominalia tres intermedia, margine postico extrorsum acutanguloso.

Allied to *Sphenocorynus*, from which it differs by the short, subquadrate, compressed, asymmetric club, with a small apical spongiouse stripe,¹⁴ the convex elytra, the longer, posteriorly

¹⁴ According to J. Faust's certainly correct morphologic comprehension, one could better say in this case: Club (this is the tomentose terminal part of antenna) even, not projecting beyond last joint of funicle.

produced mesosternal lobe, the unarmed femora, carinate posterior tibiæ, and transverse pygidium. *Heterotoxus*, another related genus, differs by differently formed antennæ, with a large part of the club spongiose, the depressed prothorax and elytra, the small pentagonal scutellum, strongly elevated femora, etc.

Pseudacanthorrhinus bipodex sp. nov. Plate 1, figs. 10a, 10b.

Rufus, antennis, vitta mediana thoracali, scutello, vittiforme, elytris vitta suturali, altera, in primo triente abbreviata, inter striam quartam et octavam, humeris vittaque marginali conjuncta, mesosterno, coxis, genubus tarsisque (interdum macula aut vitta laterali in prothorace) nigris; rostro duabus trientibus thoracis aequali, arcuato, dorso sulco mediano; prothorace latitudine distincte longiore, haud punctato; scutello latitudine triplo longiore; elytris oblongo-ellipticis, dorso sat convexis, prothorace paulo latioribus, apice singulis subtruncato-rotundatis, punctato-striatis, spatiis, praesertim tertio quartoque, convexiusculis; pygidio transverso, apice truncato luteo-setoso, sternito anali medio profunde intruso, utrinque lo valido, luteo-setoso; femoribus apice nigricantibus, tibiis maris intus fulvo-fimbriatis. Long. 11.5 ad 13, lat. 3.5 ad 4.5 mm.

LUZON, Laguna Province, Mount Maquiling. MINDANAO, Lanao Province, Iligan (*Baker*).

A red species, easily recognizable by the pattern of elytra, with the following black markings: Prothorax with three lines, one median and one marginal on each side, sometimes reduced to a patch. Elytra with a humeral spot, and connected with this the lateral margin, then the suture, the first interval except its first third, a large vitta, abbreviate in front, between the fourth and eighth striæ, the mesosternum and all coxæ, black.

Sphenophorus nigrovittatus sp. nov. Plate 1, fig. 9.

S. alfuro Heller¹⁵ affinis, sed aliter signatus, subsanguineus, metasterno, abdominis pars mediana antennarumque clava, nigro-denudatis; prothorace utrinque vitta, ante abbreviata, nigra; elytris singulis vitta, postorsum attenuata, rufo-denudata, spatiis 3. ad 5. punctis pustiliformibus cinereo-tomentosis, seriatis, sutura spatiumque primo vitta nigro-velutina, ante apicem abbreviata, ac in primo triente usque ad striam tertiam

¹⁵ Ent. Mitteil. Berlin 3 (1914) 313, pl. 5, figs. 7, 7a.

dilatata, item altera laterali apicem versus rotundato-subdilatata. Long. 9.5, lat. 3.5 mm.

MINDANAO, Surigao Province, Surigao (*Baker*).

Differs from the nearly allied *S. alfurus* Heller, from Orani, Bataan Province, Luzon, by the black pattern of prothorax and elytra; in the former this consists of a black stripe on each side abbreviated and attenuated in front, in the latter of a broad black velvety sutural stripe, extending as far as to the second stria, dilated in the first third to the third stria, and abbreviated in the apical sixth. A similar but lateral stripe extends from the shoulder to the apical callosity. Denudate reddish discal parts of elytra with three rows of ashy tomentose punctiform pustules.

Laogenia cylindricollis sp. nov., ♂, ♀.

Niger, elytris subfuscescentibus, maris rostro dimidia parte thoracis longitudine, recto, utrinque seria remote granulata, lateribus, ut parte basali, rude punctato, feminae thoracis dimidia parte longiore, paulo arcuato, seriato-punctato; antennis funiculi articulo secundo primo aequali, reliquis crassitudine longioribus, clava conica, scapo fere longitudine aequali; prothorace, maris, latitudine fere duplo (19 : 43) longiore, feminae brevior (18 : 31), lateribus fere parallelis, in primo quarto paulo ampliatis, squamulis omnino aequaliter parumque inter se distantibus; scutello punctiforme; elytris punctato-striatis, punctis perapproximatis, squamula rotundata repletis, spatiis anguste carinatis, atomis albidis remote seriatis; pygidio remotius squamoso, dorso utrinque carina longitudinali obsoleta ac obtusa; femoribus posticis abdomen paulo superantibus, anticis prothorace aequalibus; tibiis striato-punctatis intus, praesertim anticis, serrato-denticulatis; corpore subter aequaliter sat dense, meta-episternis densissime albido-squamosis; tarsorum posticorum articulo primo secundo paulo longiore. Long. 6.5 (♀) ad 8 (♂), lat. 1.2 (♀) ad 1.5 mm. (♂).

MINDANAO, Zamboanga Province, Dapitan ♂ (14808), Zamboanga ♀ (7355).

The only hitherto described species with a similar long cylindric prothorax is *L. longicollis* Pascoe,¹⁶ from Sumatra, but this is much smaller in size, has the prothorax longitudinally depressed, and the tibiae fimbriate inside.

¹⁶ Ann. Mus. Genova II 2 (1885) 305.

CRYPTODERMINÆ

Cryptoderma longicollae sp. nov., ♂.

C. collare Rits. latius ac multo maius, nigrum, cinereo-pruinosum, lineis eburneis similiter ornatum; prothorace latitudine distincte (quinta parte) longiore, lateribus in dimidia parte basali rectis, parallelis (basin versus sub-convergentibus), fortiter umbilicato-punctato, linea eburnea, mediana laterali vix tenuiore, in elytris utrinque, ante scutellum, quasi in puncto continuanda, elytris oblongo-ovatis, tuberculo subapicali nullo, rude seriato-punctatis, spatiis subconvexis, margine basali elevato, inter striam quartam et quintam exciso, inter quintum et sextum dentato-producto, linea x-forme eburnea ramis anterioribus prope ad humeros incipientibus, stria nona in duabus trientibus apicalibus eburnea; femoribus posticis tertia parte elytrorum apice extantibus. Long. 9, lat. 5.1 mm.

SIARGAO (*G. Boettcher*). A domine W. Schultze benevolenter communicatum.

*Cryptoderma mangyanum*¹⁷ sp. nov., ♂. Plate 1, fig. 12.

Nigrum, umbrino-pruinosum, elytris forma earumque signatura praecedenti similibus, sed lineis eburneis multo latioribus, in stria nona nulla; antennis articulo tertio crassitudine plus duplo, septimo hac distincte longiore; prothorace longitudine latitudine aequali, lateribus fortiter rotundatis, fortiter intruso-punctato, linea eburnea, mediana, laterali tenuiore; elytris spatio secundo quartoque, praesertim post medium, subcostatis, lineis eburneis latitudine spatium unum superantibus, margine basali utrinque alte auriculato-elevato, inter striam septimam et quartam exciso, utrinque pone excisionem subangulato-producto; femoribus posticis elytrorum apice tertia parte extantibus. Long. 13, lat. 5 mm.

MINDORO, Naujan (*E. H. Taylor*).

The two species of Philippine *Cryptoderma* last described show the ordinary x-shaped ivory incrustate lines on the elytra and are related by the comparatively short-oval acuminate form of the elytra to *C. plicatipenne* and *C. brevipenne* but are larger than these; the third Philippine species (*C. philippinense* Waterhouse) belongs to the elongate subparallel species, which has a subapical callosity on the elytra.

¹⁷ Maṅgyanes is the name by which the Filipinos native to Mindoro are known.

Cryptoderma longicollis has the prothorax elongate, parallel sided in the basal half, with the ivory middle line reaching in the first interval to the base of elytra, but not touching the scutellum. Intervals of elytra slightly convex, anterior branch of the x-shaped figure connected with the lateral stripe at the level of scutellum, the ninth stria ivory incrustation in the apical half.

Cryptoderma mangyanum has a shorter prothorax with rounded sides (male) and much broader x-shaped ivory lines on the elytra, ninth stria without ivory incrustation. The vaulted and notched basal part of the male elytra is higher than in any other species, half as high (in *C. plicatipenne* Rits. one-third) as broad.

ILLUSTRATION

PLATE 1

- FIG. 1. *Chirozetes lineolatus* sp. nov.
2. *Achirozetes kleinei* g. et sp. nov.
3. *Microzetes trochilus* g. et sp. nov.; a, funicle of antenna.
4. *Phylaitis vidua* sp. nov.
5. *Ommatolampus schultzei* sp. nov.
6. *Ommatolampus sulcirostris* sp. nov.
7. *Anathymus nigroscutellatus* sp. nov.
8. *Prodiocetes surigaonis* sp. nov.
9. *Sphenophorus nigrovittatus* sp. nov.
10. *Pseudacanthorrhinus bipodex* g. et sp. nov.; a, funicle of antenna;
b, last ventral sternite.
11. *Diasthetus crassiusculus* sp. nov.; a, funicle of antenna.
12. *Cryptoderma mangyanum* sp. nov., male.
13. *Poteriophorus regulus* sp. nov., female.

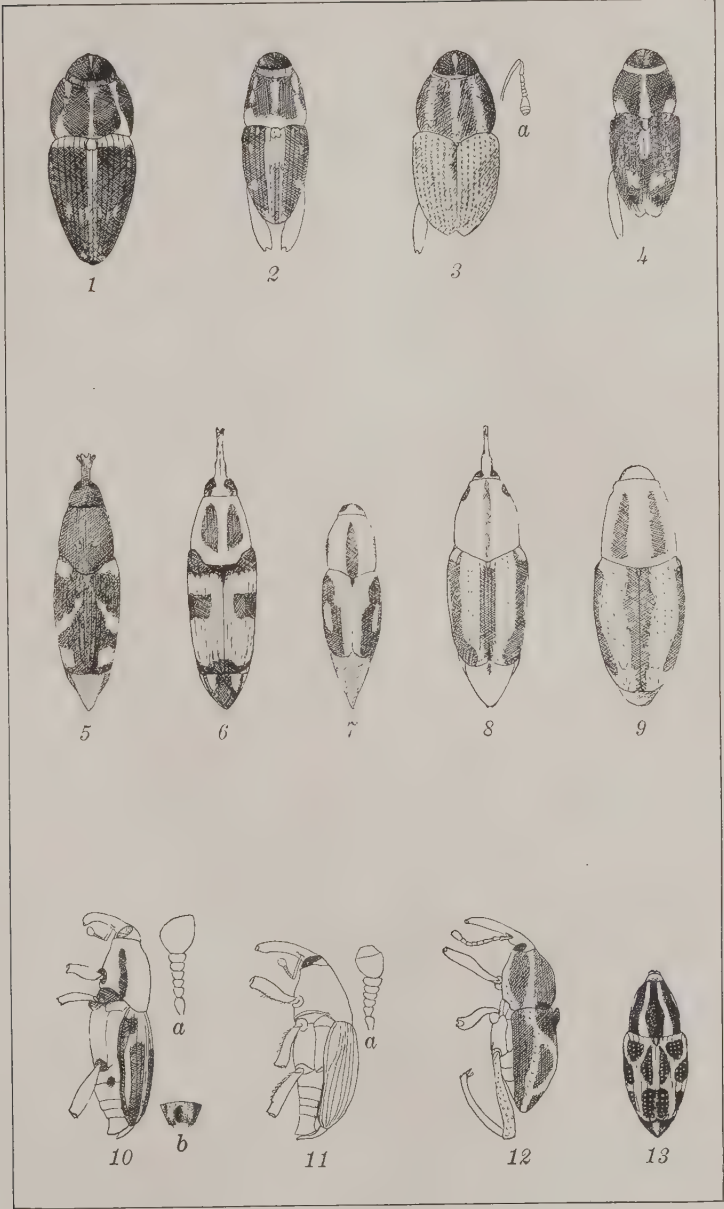


PLATE I.

THE EFFECT OF HIGH TEMPERATURES ON THE GERMINATION AND SUBSEQUENT GROWTH OF CORN ¹

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ONE PLATE AND FOUR TEXT FIGURES

INTRODUCTION

There has been a considerable increase in the use of heat in the disinfection of cereals against both insect and fungous pests, within recent years. Several publications have been issued with a view of disseminating knowledge among farmers, seedsmen, and mill owners, for the control of insects affecting stored grains and mill products. These publications are of undoubted value for that purpose, but the investigations upon which they are based too often neglect phases of the subject that are of intense interest to the plant physiologist from a scientific point of view and to the farmer and seedsman from a practical point of view. The investigators have too often been entomologists interested only in the destruction of the insect pests; or they have been heating and ventilating engineers, having the same end in view. They have paid some attention to the effect of the heat upon the edibility and the keeping qualities of the grain, but have seldom paid the amount of attention that the subject deserves to the effect of sterilizing measures on the subsequent viability of the grain. They have not worked with carefully controlled temperatures or periods of exposure, and they seldom give details as to the moisture content of the seed, the method of heating, the variety, or even the kind of seed used. Furthermore, detailed and careful experiments are seldom carried out to determine the effect of the treatment on the percentage of germination.

¹ Thesis submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in botany in the Graduate School of the University of Illinois, 1922.

The work upon which this thesis is based was done in the laboratory of plant physiology under the direction of Prof. Charles F. Hottes, and I gratefully acknowledge his help in the selection of the problem, in its development, and in the presentation of the results.

This kind of investigation is often useless to the botanist seeking definite information; but, more important, it is sometimes positively harmful to farmers and to seedsmen who, acting on the information given, treat their seed, only to find the germination lowered or the seed killed outright. Goodwin (1922) makes this statement in an Ohio Experiment Station publication: "Corn heated to a temperature of 140° F. (60° C.) for almost two days germinated almost as well as an untreated sample from the same lot." He adds: "Of course, there is the possibility that damp seed might be injured by being raised too rapidly to such temperatures as here recorded." Although I did not heat corn at 60° C., I did get severe injury after heating corn at 70° C. for one hundred forty minutes, germination being reduced from about 98 per cent to 40 per cent. The corn I used contained about 10.5 per cent moisture, which is lower than the moisture content of most air-dry corn. Similarly, De Ong (1919) working with various seeds, including corn, gives heat treatments of 100° to 158° F. for five hours, 124° to 154° F. for two hours, and 125° F. for eight hours and gets average germination percentages of 86, 88, and 94, respectively. He says the effect on grains is so small as to be almost negligible. Corn is included among the grains, though it is much more sensitive to heat than wheat or barley, and would be injured by heat that would not affect these grains.

The artificial drying of cereals or of other seeds to prevent loss in storage should likewise be carried on under carefully controlled conditions and at temperatures known to be low enough not to injure the viability of the seed at a given moisture content. This is important in the drying of corn which is to be used for seed, especially during seasons when frost necessitates an early harvesting of the crop, while it is full of moisture and liable to "heat" in storage. Insufficient data are available on the moisture-temperature relations of most of our cereal seeds, and one of the purposes of this investigation was to determine the temperature relations of corn with a known amount of moisture.

With the failure to control certain seed-borne diseases by means of chemical disinfectants has come the attempt to control them, first by hot-water treatments, then by dry-heat treatments, and finally by soaking treatments followed by heat treatment. Here again insufficient attention has been paid to the effect of these treatments on the germination and, above all, on the subsequent growth and yield of plants from treated seed as com-

pared with the growth and yield of plants from untreated seed. Many seed-borne diseases, especially those in which the fungus is within the seed itself, are being studied and an attempt is being made to control them by dry heat. Atanasoff and Johnson (1920) have reviewed the earlier work on the use of dry heat in the control of disease, preparatory to a discussion of their own results on the control of various cereal diseases borne on the seeds of wheat, barley, rye, and oats. They heated these seeds in a gas or electric oven at 100° C. for fifteen and for thirty hours. They state that the germination, in sand, was lowered slightly, compared with untreated checks, and that the plants from treated seed were slow to start but soon caught up with their checks and remained normal. They make no mention of the kind of container in which the seed was heated, whether the seed was spread out in a thin layer or heaped together in a small container, nor do they mention moisture content beyond saying, "good dry seed of barley, wheat, oats and rye is able to withstand suprisingly well the high temperature used, up to thirty hours." These results should by no means be interpreted as being applicable to corn and, before this method of seed treatment is broadcasted among farmers or seedsmen, additional work should be done to determine what is meant by "good dry seed" and how frequently it exists in the farmer's bins under ordinary storage conditions. Dickson (1920), working at the same station as Atanasoff and Johnson (1920), later recommends three hours' exposure to 100° C. as a control measure against wheat scab and against seedling blight of wheat, but says nothing further concerning methods. Walker (1922) has attempted to control cabbage black-leg by means of dry-heat treatment of the seed. He has made moisture determinations of the seed treated.

With the increasing importance of root and stalk rots of corn in the United States comes the attempt to control or to lessen their damage. Soil treatments have proved unreliable, and seed treatments have proved unsatisfactory, although Branstetter (1922) reports a lessening in the number of diseased plants from seed treated by immersion in alcohol and mercuric chloride, as compared with untreated checks. The possibility of heat treatment presents itself, but before this is attempted we should know something of the moisture-temperature relations of the corn to be treated.

The facts to be established in this investigation were: (a) the time-temperature relations of corn with known amounts of

moisture, but especially in the air-dry condition; (b) the effect of desiccation on viability and resistance to heat; and (c) the effect of heat treatment of the seed on the subsequent growth of the seedling.

Three types of corn, varying in amount of infection and susceptibility to disease under field conditions, and varying in physical composition, were used in determining these facts. Any variations in response to the conditions imposed by the experiment were noted, in the hope of explaining them by means of the differing characteristics of the kinds of corn used and thus determining the characteristics that govern the behavior of corn in response to various factors, such as temperature and humidity.

MATERIALS

The three types of corn used in this investigation varied as to their physical characters, vitality, and degree of infection with various root-rot fungi. All three types were of the Reid's Yellow Dent variety, were from the 1920 harvest, and were furnished by Mr. J. R. Holbert, of Bloomington, Illinois. According to results obtained on the germinator, Mr. Holbert classified them as: (a) apparently diseased; (b) original composite (badly diseased); and (c) apparently disease-free. Throughout this investigation these types of corn will be known as: (a) Diseased, (b) Badly diseased, and (c) Disease-free. Each of these three types he further classified according to physical characters, vitality, and degree of infection.

The physical characters of these types of corn are of interest because of the correlation known to exist between them and resistance or susceptibility to root rots. They are classified as to physical composition of kernels, indentation of kernels, brightness of shanks, brightness of kernels, development of kernels, tip covering of ears, and luster of ears; of these, physical composition, indentation, brightness of kernels, and development of kernels come under direct consideration in this investigation. These characters, expressed in percentages, are summarized in Table 1.

From Table 1 it is noted that Disease-free corn possesses, to a high degree, many of the physical characters correlated with slightly infected, resistant corn. Thus, it has a high percentage of horny, smooth, bright, plump kernels; good luster of ears; and ears with tips covered. Diseased corn has a few of the characters correlated with infected, susceptible corn, such as dull,

shriveled kernels and dull luster of ears. More important, however, is its large percentage of starchy kernels. My results indicate that this character is correlated with its ability to take up and give off moisture, and largely determines its subsequent behavior. Badly diseased, on the other hand, has many of the characters common to badly diseased corn, such as a high percentage of rough, medium bright and medium starchy kernels, and medium luster of ears. Its high percentage of medium starchy kernels probably accounts for its behavior in regard to moisture content.

After germinating thirty kernels from each ear and noting the percentage of germination and the degree and kind of infection on the germinator, Mr. Holbert classified each of the types according to vitality and degree of infection.

TABLE 2.—*Vitality and degree of infection.*

[Numbers give percentages.]

Type of corn.	Vitality.	Degree of infection.	
		<i>Fusarium.</i>	<i>Diplodia.</i>
Diseased.....	99.48	3.45	—
Badly diseased.....	96.5	12.7	1.5
Disease-free.....	99.4	0.9	—

The relative susceptibility to disease under field conditions, as indicated by the names of the three types of corn, has little effect on their viability. Mr. Holbert's tests show Diseased to have a slightly higher percentage of germination than Disease-free, while my tests (Diseased, 96.8 per cent; Badly diseased, 93.2 per cent; Disease-free, 97.4 per cent) on the corn as it was used are slightly different.

Tables 1 and 2 have been constructed from unpublished data kindly furnished by Mr. Holbert, to whom thanks are due.

The corn was received at the laboratory on the ear and was stored in a dry place in large, covered, tin boxes. In the early work individual ears of each type were used as the source of the corn tested, the number of the ear was recorded, and all of the good kernels from the ear, except those at the extreme tip and butt, were used. It was soon noticed that individual ears varied widely in their resistance to heat, their vigor of germination, and their degree of infection. In order to arrive at the extent of this variation, six ears of each type were taken

at random and tested at 80° C. and 90° C.; the results of these tests are summarized in Table 3.

TABLE 3.—*Summary of the individual variation of the ears.*

[Numbers give percentages of germination.]

Diseased.				Badly diseased.				Disease-free.					
Ear No.	80°C.	90°C.	Average.	Ear No.	80°C.	90°C.	Average.	Ear No.	First trial.		Second trial.		Average.
									80°C.	90°C.	80°C.	90°C.	
70	66.6	50.0	58.3	12	57.5	32.0	44.8	17	30.0	50.0	16.7	40.0	34.2
72	86.7	47.5	67.1	28	62.5	12.0	37.3	18	40.0	50.0	20.0	33.3	35.8
116	80.0	50.0	65.0	37	62.5	36.0	49.3	33	57.5	57.5	43.3	40.0	49.6
137	86.7	47.5	67.1	38	55.0	36.0	45.5	54	37.5	57.5	23.3	43.3	40.4
166	91.7	50.0	70.9	55	55.0	40.0	47.5	80	55.0	52.5	43.3	43.3	48.5
176	76.6	60.0	68.3	75	67.5	40.0	53.8	93	35.0	37.5	20.0	30.0	30.5

Some ears did not vary widely from the average, or were not consistent in their variation; while others, notably, Badly diseased No. 75 and Disease-free No. 33, were consistently high in percentage of germination, and still others, as Disease-free No. 93, were low in percentage of germination.

The corn kernels often had their coats broken; this was especially true of the rougher ears such as those of Badly diseased, where the shriveled, attenuated crown, which caused the roughness of the ears, is very easily broken. Such kernels were discarded, as were also those injured by the grain moth. Some kernels had their tips broken off, exposing the black cap that covers the lower part of the embryo. To determine whether these kernels were more readily injured by heat than were those with the tips intact tests were made, using the three types of corn. The tips were in most cases broken off artificially, but differed in no way from those whose tips were broken off in the shelling process.

Kernels with tips broken off gave 39.3 per cent germination, while kernels with tips intact gave 44.7 per cent germination, a difference of 5.4 per cent. There was practically no difference in length of plumule. Each type responded similarly to this treatment. No tests were made of kernels with broken crowns, though results would probably have been less significant than those given. The difference noted justified me in selecting only kernels with tips and crowns intact.

Because of the variation between individual ears, most of the investigation was carried on with composite samples obtained

by selecting the same number of good kernels from each ear and mixing them thoroughly. This composite was kept in tin cans in the laboratory.

These investigations involved the use of 30,000 kernels, tested in lots of 10 and 25, unless otherwise indicated.

METHODS

The apparatus used in the heating of the seeds was similar to that used and described by Groves.² It consisted of a copper bath 15.5 centimeters high and 21 centimeters in diameter, with a capacity of about 4 liters (Plate, 1 fig. 4). The top was perforated by ten tubulatures (3 centimeters in diameter) around the periphery and one in the middle. The baths were placed on electric hot plates. They were exactly the size of the hot plate, and a galvanized-iron sleeve was fitted around the base of the bath, extending down over the hot plate, thus preventing rapid radiation of heat and at the same time holding the bath in place. In the center tubulature of each boiler a double bulb reflux condenser made of block tin was tightly fitted. The temperature of the bath was measured by a standard, Government-tested, Centigrade thermometer which could be slipped in and out of a glass tube leading down into one of the glass phials described below. A thermometer with its phial was fitted into one tubulature in each boiler. These phials contained corn to keep the bulb of the thermometer from having contact with the glass. This left nine tubulatures which could be used for the heating of the corn.

The glass phials were 9 by 2 centimeters and were fitted with rubber stoppers through which extended 15-centimeter capillary tubes of 1-millimeter bore. These capillary tubes were used to allow for the expansion of the air on heating and thus to hasten a rapid adjustment of temperature.

A larger rubber stopper at the upper end of this capillary tube fitted the tubulatures in the copper bath and supported the phial in the liquid (Plate 1, fig. 4). By adjusting the distance between the two stoppers the phials were in all cases completely submerged, in order to make the temperature of the phials uniform throughout and also to make visible any leakage that might occur around the stoppers. If any leakage did occur the test was discarded. When not in use the tubulatures in the boiler were kept tightly closed with corks, in order to reduce to a minimum the loss from evaporation and the consequent change

² Trans. Illinois Acad. Sci. 8 (1915) 133-136.

in the boiling point of the fluid. Several tests were made to determine whether a difference in the size of the opening in the glass tubing resulted in a difference in the percentage of germination. A series of tests, using the capillary glass tubing with 1-millimeter inside diameter was contrasted with one using ordinary glass tubing with 4-millimeter inside diameter. The average percentages of germination of three trials at 80° C. and at 90° C. were 10.6 and 0.3 in favor of the ordinary glass tubes, and 4 in favor of the capillary tubes. The plumule lengths varied slightly in the same way. These results would indicate that this slight difference in size of the opening has little, if any, effect on the resistance to heat of the treated corn.

To obtain the desired temperatures, advantage was taken of the different boiling points of various liquids and of various mixtures. Thus, to secure a temperature of 100° C. a mixture of glycerine and water was used in the proportion of 13 to 87. This mixture boiled at exactly 100° C. and the condenser refluxed the liquid back into the boiler, thus maintaining a uniform boiling point. To secure temperatures of 90° C. and 80° C. mixtures of ethyl alcohol and water were used, while to secure a temperature of 70° C. a mixture of methyl alcohol and water was used. The exact proportions of the mixtures used are summarized in Table 4.

TABLE 4.—Proportions of various liquids used in obtaining temperatures from 70° C. to 100° C.

Temperature.	Distilled water.	Other fluids.	
°C.	Per cent.		Per cent.
100.....	87	Glycerine.....	13
90.....	75	Ethyl alcohol.....	25
80.....	38do.....	62
70.....	15	Methyl alcohol.....	85

Distilled water was used in each case with commercial alcohols or with glycerine. Care was taken to adjust the boiling point of the mixture before each trial and the variation in temperature was kept within 0.5° C.

The phials were kept dry and clean inside and were warmed before loading, to hasten the change in temperature to that of the bath. With the high temperatures and the short periods of heating this became an important factor. The slow rise in temperature of the phials and their contents makes it difficult to determine the temperature to which the corn was actually

exposed. This difficulty, however, has been experienced by every investigator of temperature in its effect on seeds. The method of heating was uniform for each type of corn and should have introduced no error here. In an effort to determine the speed of the temperature rise, phials fitted with thermometers were inserted in the bath, and the time required to reach certain temperatures was noted. At first the rise was very rapid; but gradually it decreased in rapidity until it was difficult to determine the rate, so slowly did it rise. An average of about fifteen minutes was required for empty phials to change from 28° to 99.5° C. Starting at 28° C., 40° C. was reached in twenty-four seconds; 90° C. was reached in four minutes; 99.5° C. was reached in fourteen minutes and thirty seconds. When the phials were loaded the rise in temperature was slightly slower than in the case of empty phials.

After the corn had been heated the phials were removed from the bath, and the corn was immediately placed in small aluminum dishes to cool. It was then placed in rag dolls to germinate. The rag dolls used were made of a good grade of bleached muslin, 8.75 by 48 inches (about 23 by 122 centimeters). Six lots of ten seeds each were placed in one rag doll, thus giving ample room for germination and growth.

The dolls were thoroughly washed, scrubbed, and boiled before using, thus insuring a certain amount of freedom from saprophytic fungi. The modified rag doll as described by Duddleston (1920) was used only where the relative degree of infection was sought. The ordinary unwrapped method proved adequate to show germination vigor and was much quicker and cheaper than the modified method. The dolls were placed in lukewarm water and allowed to soak for ten hours. They were then removed and allowed to drain thoroughly and placed in gallon jars provided with drainage, and other jars were placed over them (Plate 1, fig. 1). This method proved satisfactory and convenient. These germinators were placed in a temperature case with the temperature accurately regulated at 30° C. Haberlandt (1874) gives the optimum temperature for the germination of corn as 34° C., and Lehenbauer (1914) says the optimum temperature for the growth of maize seedlings is between 29° and 32° C. The advantages of the constant temperature and the fact that the temperature cases were a permanent part of the laboratory's equipment outweighed the disadvantage of building apparatus to make pos-

sible a slight rise in temperature to the reported optimum. After five days (including the soaking period) at 30° C. the rag dolls were opened and read for amount of germination and length of plumule (Plate 1, fig. 3).

It is realized that the rag doll is not an ideal method of germinating corn, but it is the quickest, best method of handling a large number of germinating kernels in a way that would make the results comparable to those obtained by the farmer in testing his corn. Every method has its disadvantages, but those of the rag doll seemed least, because it is readily available, compact, quickly and easily handled, and tends to familiarize one with a widely used method. It was noticed that the outside of the rag doll gave slightly poorer germination than the inside, and that the lower part of the rag doll gave poorer germination than the upper part.

The wire cores (Plate 1, fig. 3) on which the rag dolls were rolled probably gave as great aëration to the inside of the dolls as the outside. This, coupled with better moisture conditions, gave better germination on the inside than on the outside. Too much moisture caused a poorer germination in the lower part of the rag doll than in the upper part. These variations, however, acted equally upon all three types and did not introduce an error in the results.

Waggoner (1917) has clearly shown one of the reasons for the discrepancies in the results obtained by earlier investigators on the effect of high temperature on seeds; namely, the method used in heating. In his own work he has shown the decided difference in the effect of heat on viability when the seeds were heated in an open oven and when heated in flasks. In order to determine whether this difference held also for the types of corn under investigation, air-dry corn was heated at 70° C. for 100, 120, 140, and 160 minutes in phials as already described and also in large test tubes, 26 millimeters in diameter and 150 millimeters long. These test tubes were given several turns of electricians' friction tape around the top so as to make them fit the tubulatures in the bath tightly, and more tape was used to seal the tubes into the tubulature so as to prevent the escape of steam. These test tubes quickly reached the same temperature as the bath, and the corn to be treated was placed in small wire baskets and lowered into the tubes. The corn was thus in a dry heat equal to the heat applied to the phials and was treated the same length of time in each case. In the

one case there was much space for the moisture to escape from the kernels while in the case of the phials fitted with capillary tubes a very limited amount of moisture could escape.

Table 5 gives the significant results of a test conducted with air-dry corn at 70° C.

TABLE 5.—*Heating air-dry corn in open test tubes compared with heating in phials, at 70° C.*

[T, open test tubes; P, phials.]

PERCENTAGE OF GERMINATION.

Type of corn.	Minutes heated.								Average.	
	100		120		140		160			
	T	P	T	P	T	P	T	P	T	P
Diseased-----	90	80	100	30	90	70	100	30	95.0	52.5
Badly diseased-----	100	40	80	50	60	20	60	12	75.0	30.5
Disease-free-----	100	70	100	50	100	10	100	20	100.0	37.5
Average-----									90.0	40.2

LENGTH OF PLUMULE IN MILLIMETERS.										
Diseased-----	113	49	100	51	80	19	91	7	96.0	31.5
Badly diseased-----	71	7	76	15	29	10	42	8	54.5	10.0
Disease-free-----	118	49	98	12	81	13	91	13	97.0	21.8
Average-----									82.5	20.8

Waggoner (1917) states that the chief factor determining the resistance of seeds heated to the same temperature by different methods is the amount of moisture absorbed or lost during the treatment. On this basis the results given in Table 5 are undoubtedly more significant than they would be at a higher temperature, because a long heating period allows much moisture to escape before injury or killing takes place. At high temperatures and short heating periods it is doubtful if any such difference would be noted. The average difference of 49.8 per cent in germination and 61.7 millimeters in length of plumule, and the consistently lower percentage of germination and length of plumule of those kernels heated in phials, at all temperatures used, show conclusively that less heat was required for injury or death when the corn was heated in closed phials than when the corn was heated in open test tubes.

After it was heated the corn was immediately placed in aluminum dishes to cool. This was done in order to cool the corn as rapidly as possible after its period of heating was over. To determine if this method was the best one to follow, air-dry

corn was heated to 90 °C. for from four to seven minutes, one series being allowed to remain in the corked phials to cool, and the other being placed in the aluminum dishes to cool. The percentage of germination of that cooled in the phials was 60.8, while that cooled in the dishes gave 65 per cent germination, a difference of 4.2 per cent. Similarly the difference in plumule lengths was 23.3 millimeters in favor of the corn cooled in the aluminum dishes.

A method was devised whereby the corn could be quickly loaded into the phials which were already in place and heated to the desired temperature, but the results from this method did not differ from those obtained by loading the phials and then inserting them into the bath; hence this method was not used.

RESULTS AND DISCUSSION

EFFECT OF HEAT ON AIR-DRY CORN

No extensive work has been done on the time and the temperature required to injure or to kill corn by subjecting the kernels to heat. Almost without exception, where time and temperature are given, no mention is made of the moisture content of the corn, though it has been known for many years that the drier the seeds are the greater the degree of heat that they can withstand. Miss White (1909), in her studies on ferments in seeds, heated corn at 99° to 100° C. for six and one-half hours and got no germination, while corn heated for one hour at 122° and 124° C. was also killed. Burgess (1919), in investigating possible injury done to the vitality of seeds by heat treatment for insect pests, found that corn gave 68 per cent germination when treated at 176° F. (80° C.) for one hour, and 32 per cent when treated for three hours. Montgomery (1917), investigating a similar problem, said that "the germinating quality of grain is destroyed at 150° F. (65.6° C.) and probably injured at 5° less (62.8° C.), if long exposed." Ear corn hanging in a seed room which was disinfected several times at 140° F. (60° C.) for several hours at a time, was apparently not injured.

All of the work that has been done, and it is small in amount, is of the same fragmentary nature as that reported above. Thus it seemed the first task to find out the exact time and temperature relations of air-dry corn under the conditions of the experiment; namely, dry heat applied to corn in phials fitted with capillary tubes, the volume of the phial being about eight times that of the kernels being tested.

It should be borne in mind that the moisture content averages of air-dry corn, as kept in the laboratory, were as follows: Diseased corn, 10.93 per cent; Badly diseased corn, 10.64 per cent; Disease-free corn, 10.41 per cent. These percentages are based on the air-dry weight of the seed and were determined as described below. It is to corn of the above-stated moisture content, that the time and temperature figures given in Tables 6, 7, 8, and 9 apply. Although the moisture content of the corn varied somewhat, it was less than if it had been stored outdoors, subject to varying climatic conditions.

The averages of many moisture determinations made on samples from all over the State of Illinois, by the division of crop production, College of Agriculture, University of Illinois, are as follows: For samples received and tested in February, 15 per cent; March, 13 per cent; April, 12 per cent. These figures should not be lost sight of in the drying of corn or in heat treatments for insect or fungous pests.

TABLE 6.—*Air-dry corn heated at 100° C. in an oven.*
PERCENTAGE OF GERMINATION.

Type of corn.	Minutes heated.					Average.
	5	7.5	10	12.5	15	
Diseased, 184*	100	24	44	0	0	33.6
Badly diseased, 71	88	56	0	8	0	30.4
Disease-free, 77	92	72	32	4	0	40.0
LENGTH OF PLUMULE IN MILLIMETERS.						
Diseased, 184	108	19	11	0	0	27.6
Badly diseased, 71	102	71	0	7	0	36.0
Disease-free, 77	152	112	14	4	0	56.4

* Refers to number of ear used.

The corn heated at 100° C. (Table 6), was heated in an electric oven in open aluminum dishes. This accounts for its not being killed until after fifteen minutes exposure, while the same kind of corn was killed in nine minutes at 90° C. when heated in phials. This illustrates again the difference due to the method of heating. At 100° C. the period required to kill, when the phials were used, was so short that it was difficult to get results of much comparative value, because of the slow rise in temperature in the phials and the resulting uncertainty as to just what temperature was reached in the phials during the shorter periods of heating. Only a few minutes were re-

quired to kill when 100° C. was used, and the actual temperature to which the corn was subjected at the end of this time was undoubtedly below 100° C.

TABLE 7.—*Air-dry corn heated at 90° C. in phials.*

PERCENTAGE OF GERMINATION.

Type of corn.	Check.	Minutes heated.							Average.
		3	4	5	6	7	8	9	
Diseased.....	100	100	90	90	80	70	10	0	55.7
Badly diseased.....	100	90	100	90	80	70	0	0	61.4
Disease-free.....	100	100	100	80	60	70	20	0	61.4

LENGTH OF PLUMULE IN MILLIMETERS.									
Diseased.....	132	118	114	98	58	103	5	0	70.9
Badly diseased.....	107	119	94	101	96	52	0	0	66.0
Disease-free.....	135	126	122	98	68	89	51	0	79.1

TABLE 8.—*Air-dry corn heated at 80° C. in phials.*

PERCENTAGE OF GERMINATION.

Type of corn.	Check.	Minutes heated.					Average.
		10	12.5	15	17.5	20	
Diseased.....	80	96.7	70	40	10	0	43.3
Badly diseased.....	100	90.0	60	40	0	0	38.0
Disease free.....	100	93.3	70	53.3	0	10	45.3

LENGTH OF PLUMULE IN MILLIMETERS.							
Diseased.....	151	132.3	73	20.7	5	0	46.2
Badly diseased.....	169	110	77	32.3	0	0	43.9
Disease free.....	172	127	90	26.6	0	5	49.7

TABLE 9.—*Air-dry corn heated at 70° C. in phials.*

PERCENTAGE OF GERMINATION.

Type of corn.	Minutes heated.					Average.
	60	80	100	120	140	
Diseased.....	90	90	80	40	50	70.0
Badly diseased.....	90	70	60	60	50	66.0
Disease free.....	100	80	50	20	20	54.0

LENGTH OF PLUMULE IN MILLIMETERS.						
Diseased.....	114	110	79	39	40	76.4
Badly diseased.....	126	88	64	13	8	59.8
Disease free.....	135	78	71	49	54	77.4

When 90° C. was used and the corn treated in phials complete killing took place at nine and ten minutes, while injury to germination was manifest at five minutes. A slight decrease in plumule length, already noticeable at three minutes when compared with the check, may be due to retardation of germination and growth caused by heating, or it may be due to actual heat injury. It is possible that the corn heated for three minutes would finally overcome the retardation of its growth, and give as great a growth as the check. No studies were made on this point, but it was noticeable throughout the entire investigation (see Tables 6, 7, 8, and 9), that the length of plumule at the end of five days is much less in those seeds heated for a longer period than in those not heated so long. Much of this is due, I am convinced, to actual injury done by the heat, which the plant can never overcome. In any case, the effects of heat are more quickly noticeable in length of plumule than in percentage of germination. Care must be taken, however, to draw conclusions only from considerable numbers because of the greater variation in plumule length, as compared with percentage of germination.

Air-dry corn heated at 80° C. in phials, is practically all killed after twenty minutes and is all killed after twenty-five minutes exposure. Injury is already noticeable after ten minutes exposure.

Limited data do not allow me to give the exact length of time required to kill at 70° C., though injury is apparent after eight minutes exposure. A series which was made unusable by being read too early indicates that after longer periods of exposure (160 and 180 minutes) the Badly diseased corn and the Disease-free corn are almost completely killed while the Diseased corn germinates 50 and 30 per cent. The whole series averages as follows: Diseased, 55 per cent; Badly diseased, 28.3 per cent; Disease-free, 26.7 per cent; with the plumule lengths in a similar ratio. This behavior is similar to that experienced in the heating of desiccated corn, discussed below. It further resembles the results obtained on heating desiccated corn, in that the differences in resistance are most noticeable at lengths of exposure which are highly injurious. This is borne out by the results given in Table 9 where the resistance to heat is exactly opposite to that recorded in Tables 6, 7, and 8.

This interesting and significant relationship between the different types of corn and their varying resistance to heating at low and at high temperatures is shown in Table 10. This may

be due to the greater amount of water given off by Diseased corn during the long heating process, at a comparatively low temperature, than by the other two types of corn and the consequent greater resistance to heat.

TABLE 10.—*Summary of results obtained by heating corn at a low temperature (70° C.) compared with results obtained by heating at high temperatures (80° C. to 100° C.).*

[Numbers give germination percentage.]

Temperature.	Dis- eased.	Badly diseased.	Disease- free.
°C.			
70.....	70.0	66.0	54.0
Average of 80, 90, and 100.....	30.9	43.3	48.9

The average of results for 80°, 90°, and 100° C. given above, together with the results of moisture determinations given in Table 14, justifies the statement that air-dry Diseased corn contains the most moisture and is least resistant to heat, Disease-free corn contains the least moisture and is most resistant to heat, while Badly diseased corn is intermediate in both moisture content and resistance to heat.

DESICCATION

From the time of the earliest investigations to the present increasing importance has been ascribed to the moisture content of grains as affected by high temperature. As a result, in most recent articles, with some notable exceptions, dealing with the effect of heat on viability the authors are careful to state fully the conditions of the experiment, the seed used, the method of heating, and the moisture content of the seed. Waggoner (1917) has summarized the earlier work on the relation of moisture content to viability of seed heated to different degrees, and his own work is the first detailed quantitative piece of work, using one kind of seed. He has shown that the resistance of seeds of radish, exposed to high temperatures, is inversely proportional to their initial water content at the time of heating.

The purpose of this part of the investigation, then, was to determine to what extent this was true of corn, to ascertain the actual time and temperature relations of corn desiccated for various periods of time as compared with air-dry corn, and to determine if the three types of corn used responded similarly to this treatment.

Two-quart Mason fruit jars were fitted with rubbers and tightly fitting screw covers. Hooks were soldered into the

middle of these covers, from which hung paraffined wire baskets filled with corn (Plate 1, fig. 2). About 150 cubic centimeters of concentrated sulphuric acid (specific gravity, 1.84) were placed in the bottom of each jar as the desiccating agent. The moisture content of each of the three types of corn was thus gradually lowered and at intervals corn from the baskets was tested to determine its resistance to heat. Care was taken to prevent inequality in the rate of desiccation by having the top of the column of corn the same distance from the surface of the acid, in each type of corn. Sets of these jars were started at intervals in order to have a succession of corn of different moisture contents for a series of trials. The jars were placed in a 30° C. constant temperature case and were removed only while being tested. As the length of time of desiccation increased, the temperature used was increased and the time of exposure lengthened. The results of trials at various times and temperatures, after desiccation of 1, 2, 4, 6, 8, 9, 10, 12, 14, 15, 17, 20, 23, 27, 31, and 100 days are given in Table 11. The results are expressed as percentages of germination and these are averaged at the foot of the table. Those treated at 80° C. are grouped in the lower left hand corner of the table, those at 100° C. in the upper right-hand corner, and those at 90° C. in the middle of the table; and each set of results is divided from the others by a heavy zigzag line. Thus, the three types of corn which had been desiccated for 8 days were treated at 90° C. for 35, 40, 45, and 50 minutes and also at 80° C. for 100, 110, 120, and 130 minutes, and the percentage of germination for each is given in its proper place.

Difficulty was encountered in determining the proper time and temperature to use in testing the corn. As desiccation steadily decreased the moisture content, the time and temperature of treatment had to be increased in order to be injurious enough to give significant results. At the beginning of the desiccation period and with the lower temperature the change in time was rapid, while toward the end of the desiccation period and with the higher temperatures the change was slow. As a result of this constantly changing resistance of the corn to heat, much of my early work was of little value, except to indicate the proper time and temperature to use for corn desiccated a certain length of time. Hence the need for a succession of desiccations in order to get significant results.

It is evident from Table 11 that corn desiccated 2 days, containing 8.78 per cent moisture and killed when exposed for 20

TABLE 11.—Percentage of germination of corn desiccated for different lengths of time over sulphuric acid.

	1 Day	2 Days	4 Days	6 Days	8 Days	10 Days	12 Days	14 Days	15 Days	17 Days	20 Days	23 Days	27 Days	31 Days	100 Days																																	
	Diseased Sew. Dis. fr. Disease-free	Diseased Sew. Dis. fr. Disease-free	Diseased Sew. Dis. fr. Disease-free	Diseased Sew. Dis. fr. Disease-free	Diseased Sew. Dis. fr. Disease-free	Diseased Sew. Dis. fr. Disease-free	Diseased Sew. Dis. fr. Disease-free	Diseased Sew. Dis. fr. Disease-free	Diseased Sew. Dis. fr. Disease-free	Diseased Sew. Dis. fr. Disease-free	Diseased Sew. Dis. fr. Disease-free	Diseased Sew. Dis. fr. Disease-free	Diseased Sew. Dis. fr. Disease-free	Diseased Sew. Dis. fr. Disease-free	Diseased Sew. Dis. fr. Disease-free																																	
10		80 80 80					100 80 100																																									
12 1/2		50 100 80	60 70 90				80 30 50							100°C																																		
15		20 20 80	20 20 70				40 0 10	40 0 20		60 20 30		90 70 90																																				
20		0 0 70	0 0 40				0 10 0	10 0 10		20 0 10		80 40 40																																				
25			65 50 10	70 10 20			80 60 70	90 50 90	0 0 0	0 0 10		30 0 0	90 10 20																																			
30			50 0 0	70 40 40			100 50 70	60 50 80		0 0 0		0 0 0	40 10 10	40 30 50	80 30 60																																	
35				60 20 30	90 40 90		60 60 60	20 60 80				70 10 0	80 10 30	70 40 90																																		
40				80 0 10	90 70 80		90 30 40	100 30 60					80 10 86	0 50																																		
45					90 - 80			90 90 90					40 0 0	- - 39																																		
50					50 40 20			90 50 80					40 0 0																																			
55								90 60 70					50 0 30																																			
60								70 50 50	80 30 50				60 0 0																																			
65								90 30 20	80 60 70																																							
70			100 80 80					60 30 20	65 30 30		100 60 70																																					
75			100 80 90	100 90 100				50 20 50	80 60 80		90 70 100																																					
80			100 80 90	50 70 80					50 10 40		80 80 50																																					
85			100 90 80	100 70 80							80 60 70																																					
90			90 70 80						20 40 40						40 - 60																																	
100					90 70 95				70 0 50																																							
110		80°C			100 80 100				50 20 20	80 0 10																																						
115																																																
120					90 40 90	100 80 100			20 10 20	70 0 0					80 70 40																																	
125													70 40 70																																			
130					90 60 80					50 0 0																																						
135													90 60 60																																			
145													80 60 60																																			
150						90 60 80									70 90 30																																	
155													80 60 70																																			
160																																																
165										60 10 10																																						
180										90 10 10		70 60 0																																				
195										10 0 0		70 40 40																																				
210										70 0 0		80 50 30																																				
225												100 60 30																																				
Average	925	750	795	420	600	520	861	611	611	775	463	550	863	571	794	866	366	700	920	550	725	609	353	427	468	229	364	667	0	33	425	50	75	875	675	725	767	589	289	645	245	345	787	235	598	633	800	433

minutes, at 90° C. is very much less resistant to heat than corn desiccated 23 days, containing 5.75 per cent moisture and giving a germination of 63.3 per cent after exposure to 90° C. for 225 minutes. Similarly, corn desiccated 14 days, containing 6.11 per cent moisture and killed when exposed for 30 minutes at 100° C., is much less resistant than corn, desiccated 100 days, containing 2.15 per cent moisture and giving 63.3 per cent germination after exposure to 100° C. for 150 minutes. This relation existing throughout the table justifies the statement that, without regard to the type of corn used, the resistance of corn to heat varies inversely to its moisture content at the time of heating.

Probably the most significant fact brought to light by the desiccation study is the varied response of the different types of corn to the treatment. Beginning with the first day of desiccation and continuing throughout the experiment (100 days), the percentage of germination of Diseased after heating is much higher than either Badly diseased or Disease-free, while Badly diseased is somewhat lower than Disease-free, which occupies an intermediate position throughout. The averages of Table 11 are brought together in Table 12 and make these differences more evident.

Using the percentage of germination of Disease-free corn as zero, the difference between Diseased and Disease-free is plotted in fig. 1 as a solid line, and the difference between Badly diseased and Disease-free is plotted as a broken line. Thus, after twelve days desiccation, Diseased has a germination 18.2 per cent higher than Disease-free and hence is plotted as plus 18.2 per cent, while Badly diseased has a germination 7.2 per cent lower than Disease-free and hence is plotted as minus 7.2. In only one instance (two days) does Diseased have a lower germination than Disease-free and Badly diseased a greater germination than either, while Badly diseased consistently shows a lower germination than Disease-free.

The averages of all germinations of desiccated corn are as follows: Diseased, 71.8 per cent; Badly diseased, 48.7 per cent; Disease-free, 50.2 per cent.

The difference in germination in favor of Diseased is clearest where the temperatures are highly injurious; for example, the 90° C. series at fifteen days, the 100° and 90° C. series at seventeen days, and the 100° C. series at twenty-seven days, where almost complete killing occurred in both Disease-free and Badly diseased while Diseased gave a fair percentage of germination.

The differences are not so great in series such as that of 80° C. at four days, where the time of heating was not long enough to be injurious, and the differences may even be in favor of Disease-free or Badly diseased, where very little heat is applied, due probably to the superior vitality of Disease-free when not subjected to high temperatures.

Table 13 brings together the average plumule lengths of the corn treated after desiccation. Although it does not in all cases follow Table 12, yet the relative ranking of the types based on plumule length is very similar to that of the percentages of germination. The average of all plumule lengths shows that

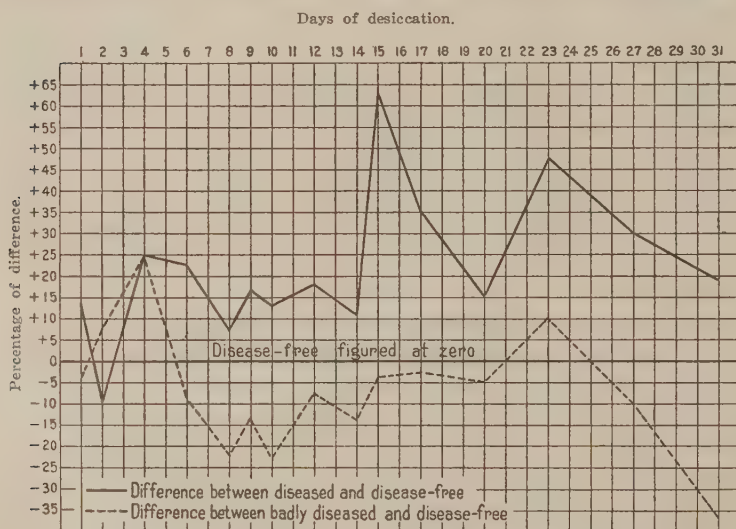


FIG. 1. Graph showing difference in percentage of germination between Diseased and Disease-free corn and between badly Diseased and Disease-free corn, after desiccation and heat treatment.

Diseased corn has the greatest plumule length, Badly diseased the least, and Disease-free is intermediate, plumule length thus having the same ranking as the percentage of germination.

Some difference of opinion has existed and still exists concerning the effects of desiccation on the viability of seeds. Some investigators, notably Ewart (1897), have held that it is impossible to reduce the moisture content of the seed much below 2 to 3 per cent of air-dry weight without affecting germination injuriously. The more recent work of Waggoner (1917), Harrington and Crocker (1918), and Walker (1922) has shown that some seeds can be reduced to a very low moisture

content without injury to their viability. The work of earlier investigators along this line has been reviewed by Harrington and Crocker (1918). In their own work they carefully dried several kinds of seeds in vacuo over calcium oxide and over concentrated sulphuric acid. They reduced the moisture content of Kentucky blue grass seed to 0.1 per cent and then heated it for six hours at 100° C., reducing it still more. The seed thus treated gave only a slightly lowered germination (5 per cent), though its germination energy was considerably reduced. The germination of barley and Sudan grass was not lowered by drying, even though the moisture content was reduced to 0.5 and 0.6 per cent. Johnson grass was slightly injured by being dried to a moisture content of 0.1 per cent. Wheat with moisture content reduced to 0.9 per cent was not injured.

Waggoner (1917) dried radish seed first at 60° C. and then at 100° C., reducing the moisture content to 0.4 per cent without affecting the germination. Walker (1922), in an attempt to control the black-leg fungus of cabbage by desiccation and dry-heat treatment of the seed, reduced the moisture content to 0.72 per cent (dry-weight moisture content) by heating at 85° C., without reducing germination perceptibly; but when the moisture content was reduced to a lower percentage than this by heating twenty-four or more hours at 95° C. the germination was lowered somewhat. He says: "Desiccation at high temperatures (85° C. to 95° C.) caused a gradual reduction in viability, which was accompanied by retardation in germination." He found that "cabbage seed is not uniformly resistant to desiccation at high temperatures."

Corn that had been in desiccators for 100 days contained an average of 2.18 per cent moisture and germinated 87 per cent after being heated 1.5 hours at 100° C. Corn that had been desiccated for 115 days and heated at 70° C. for 32 hours gave 80 per cent germination in soil. A limited amount of corn that had been desiccated for 115 days and heated at 70° C. for 60 hours had a moisture content of 2.14 per cent, very little, if any, moisture having been driven off by the 70° C. heat. As soon as this same corn, desiccated for 115 to 117 days, and further desiccated at 70° C. for 60 hours, was heated at 98° C. in the dry oven for 20 to 32 hours, no germination was obtained, while the moisture content of the different types was 0.71, 1.19, and 1.16 per cent. The injury may have resulted from the high temperature rather than from the extreme desiccation; as my data are limited, it is unwise to draw conclusions therefrom.

MOISTURE DETERMINATIONS

In order to know definitely the amount of moisture present in the corn used and the exact effect of drying over sulphuric acid on the amount of this moisture, it was necessary to make a series of moisture determinations of air-dry corn and corn dried for various periods of time. Two determinations were made in November by the division of crop production, College of Agriculture, University of Illinois, on 100-gram samples, using the Duvel method, resulting in Badly diseased 10.4 per cent and Disease-free 10 per cent. All subsequent determinations were made by placing the corn (10 kernels) in weighed aluminum dishes and reducing to constant weight in an electric drying oven at 100° C.

In Table 14 are given the moisture determinations made on the air-dry and the desiccated corn. The figures are based on

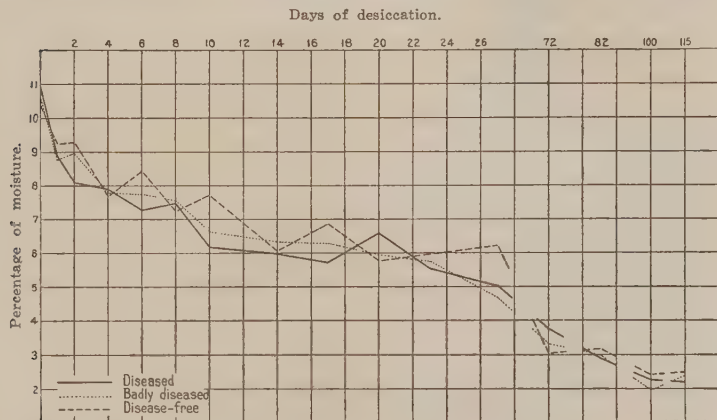


FIG. 2. Graph comparing the moisture content of the three types of corn, air-dry and after varying lengths of time in the desiccator.

single determinations, except air-dry (three determinations) and eight and ten days (two determinations each). The moisture is expressed in percentages, based on the air-dry weight.

Reducing Table 14 to a graph (fig. 2) the moisture relations of the three types of corn can best be expressed by showing relative water loss after different periods of desiccation, up to 27 days. The moisture content of the three types of corn, after 72, 82, and 100 days of desiccation, is shown at the right of the graph. It will be noted that there is a fairly steady decrease in the moisture content. Diseased contains the most moisture in the air-dry condition but soon falls to the least and remains

TABLE 14.—*Moisture content of air-dry and desiccated corn.*

[Moisture content expressed in percentages.]

Type of corn.	Air-dry.	Days desiccated.													
		1	2	4	6	8	10	14	17	20	23	27	72	82	100
Diseased	10.93	8.87	8.09	7.87	7.28	7.49	6.19	5.98	5.70	6.60	5.53	5.02	8.76	2.88	2.23
Badly diseased	10.64	8.77	8.97	7.79	7.74	7.56	6.46	6.32	6.28	5.94	5.77	4.69	3.32	3.00	1.92
Disease-free	10.41	9.23	9.23	7.70	8.43	7.22	7.73	6.05	6.87	5.79	5.96	6.30	3.04	3.17	2.40
															2.45
															2.35
															1.16

^a Heated at 70° C. for 30 hours.^c Heated at 70° C. for 60 hours; at 98° C. for 20 hours.^b Heated at 70° C. for 60 hours.^d Desiccated 117 days; 70° C. for 60 hours; 98° C. for 32 hours.

there fairly constantly; Disease-free contains the least moisture in the air-dry condition but loses water less rapidly and soon contains the most; while Badly diseased maintains an intermediate position.

The fifteen moisture determinations made on corn desiccated from 1 to 115 days, inclusive, given in Table 14, may be grouped according to frequency; that is, the number of times out of the fifteen that each type of corn contains the least, the medium, and the greatest amount of moisture (see Table 15). This is graphically shown in fig. 3, the black spaces indicating the number of times each type of corn contains the least amount of moisture; the clear spaces, the medium amount; and the cross-hatched spaces, the greatest amount.

The differences in amount are not large, however, the average of all moisture contents being as follows: Diseased, 5.71 per cent; Badly diseased, 5.79 per cent; Disease-free, 6.11 per cent.

GRADIENT OF DESICCATION

In the process of desiccation, with the corn in long wire baskets suspended over acid and with the bottom of the basket within 15 millimeters of the surface of the acid and the top within 115 millimeters of the surface, it seemed natural to question whether desiccation was exactly uniform throughout

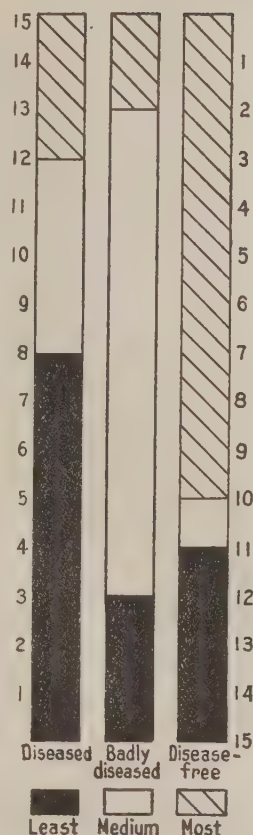


FIG. 3. Graph showing the frequency with which the different types of corn, after varying lengths of time in the desiccator, contained the least, the most, and medium amounts of moisture; based on fifteen determinations.

TABLE 15.—Number of times, out of fifteen determinations, that each type of corn contains the least, medium, and greatest amounts of moisture.

Type of corn.	Least.	Medium.	Greatest.
Diseased.....	8	4	3
Badly diseased.....	3	10	2
Disease-free.....	4	1	10

the column of corn. In view of the methods sometimes used to secure moisture or desiccation gradients over water, salt solutions, or mixtures of sulphuric acid and water in open vessels, it was necessary to determine whether complete uniformity of desiccation occurred throughout a tightly closed vessel. The same paraffined wire baskets that were used in desiccation were utilized and only Diseased corn was experimented with. These desiccators were placed in a 30° C. constant temperature case and the corn used after 8, 9, 12, and 16 days desiccation. When ready for testing, the column of corn was divided into three equal parts, upper, middle, and lower, by sticking short pieces of copper wire through the column of corn at the proper places until they formed a network which held the corn so that each third could be removed separately. Each third was then placed in a wire basket in the desiccator so it would not absorb moisture while being tested. Each third made about twelve lots of 10 kernels each, which were tested at a temperature and for a period of time known to be injurious. Thus after 16 days desiccation, 10 kernels from each third of corn were heated 10, 11, 12, and so on up to 32 minutes. Corn desiccated 8, 9, and 12 days was heated at 90° C., while corn desiccated 16 days was heated at 100° C. The results of these series are summarized in Table 16.

TABLE 16.—*Summary of the desiccation gradient of Diseased corn.*

PERCENTAGE OF GERMINATION.

Position in desiccator.	Days desiccated.				Average.
	8	9	12	16	
Upper.....	84.0	70.9	35.5	70.8	65.3
Middle.....	75.0	63.3	37.7	68.5	63.6
Lower.....	66.0	60.0	32.2	68.5	56.6
Difference between upper and lower ..	18.0	10.9	3.3	2.3	8.7

LENGTH OF PLUMULE IN MILLIMETERS.

Position in desiccator.	Days desiccated.				Average.
	8	9	12	16	
Upper.....	78.0	67.1	59.3	78.3	70.8
Middle.....	73.0	60.0	69.0	79.2	70.3
Lower.....	72.0	70.6	53.6	75.2	67.9
Difference between upper and lower ..	6.0	3.5	6.3	3.6	2.9

From the data in Table 16 it is evident that the corn from the upper one-third of the basket, which was farthest from

the surface of the acid, was the most resistant to heat, while that from the lower one-third, closest to the acid, was the least resistant. To reduce to a single figure the difference in germination between the upper and the lower parts, the percentage of germination of the lower was subtracted from that of the upper and the resulting figure given at the foot of each section of the table. These figures indicate that after 8 days of desiccation the corn in the upper one-third gave 18 per cent better germination after heating than that in the lower. With increased desiccation, the difference became less, until after 16 days it was only 2.3 per cent. It would probably slowly approach zero as a limit so that with time the desiccation would become uniform throughout. Data are not available to indicate what the ratio would be following 1 to 8 days desiccation; but it probably would describe a regular curve, as there is little difference after a short period of drying and the difference increases rapidly to a climax and then slowly decreases to zero, the climax coming on or before the eighth day of desiccation.

The length of plumule varies more widely, as is usual, but the averages rank the same as the percentages of germination. The difference between the upper one-third and the lower one-third is slight throughout the series, but is always in favor of the upper.

Only one kind of corn (Diseased) having been used, the difference in resistance to heat of the corn in the upper and lower thirds of the basket must be due to a difference in moisture content. To determine what difference existed, moisture determinations were made after 17 days desiccation of corn from the upper, middle, and lower parts of the basket, with the following results: Upper, 5.70 per cent; middle, 6.03 per cent; lower, 6.30 per cent, giving a difference of 0.60 per cent in favor of the upper. This indicates that the greater resistance to heat of the corn in the upper one-third of the basket as compared with that of the lower one-third was due to its lesser moisture content. In view of this slight difference in desiccation care was taken always to have the upper part of the column of corn the same distance from the surface of the acid in each of the three types of corn under test, so as not to introduce an error.

DAILY VARIATION

It was readily noticeable, in the heating tests, that varying results were obtained on successive days, even though the same type of corn, the same degree of heat, and the same period of exposure were used. This seemed to be correlated with out-

side climatic conditions (humidity) and, as the ventilators in the laboratory were open part of the time, the laboratory air varied in humidity also. To simulate conditions under which corn would be stored in open cribs on the farms of Illinois, shelled corn of the three types was placed in wire baskets and hung outdoors, under a rooflike shelter, suspended on a wire strung between two wings of the greenhouse, open to all air currents but protected from direct sunlight and from rain. Tests made on this corn in March and April will serve as a guide in treating crib corn for fungous or insect pests, during the rainy spring season, by means of heat, and will give the limits of time and temperature beyond which injury to germination would result. Furthermore, it was desirable to find out if the variation in the same test from day to day was actually due to variation in relative humidity of the air and, if so, how rapidly and to what extent the variation in moisture content of the corn followed the variations in atmospheric humidity. The variation in moisture content of the corn was not measured directly but was measured by the variation in percentage of germination following heat treatment; a low germination indicated a high moisture content of the corn, correlated with a high relative humidity of the atmosphere.

A check test was made on the air-dry corn just before it was hung outdoors (on March 28) and at intervals afterward up to April 26. Each test consisted of a check and ten kernels of each type of corn heated at 90° C. for 3, 4, 5, 6, 7, 8, and 9 minutes.

The percentages of germination of each type of corn, after the heat treatments, were added and the totals used to construct the graph in fig. 4. Thus, on April 2, Diseased, Badly diseased, and Disease-free corn from the baskets hanging outdoors was treated at 90° C. with the result in germination indicated in Table 17. The total does not include the check, which did not vary. The totals for each test are summarized in Table 18.

TABLE 17.—*Result of heating corn which had been exposed to outdoor climatic conditions.*

[Numbers give percentages of germination.]

Type of corn.	Check.	Minutes heated.							Total.
		3	4	5	6	7	8	9	
Diseased.....	100	100	70	50	40	0	0	0	260
Badly diseased.....	100	90	90	80	30	0	0	0	290
Disease-free.....	100	90	70	60	30	0	0	0	250

TABLE 18.—*Daily variation in the germination of corn exposed to outdoor climatic conditions.*

[Numbers give totals of germination percentages.]

Type of corn.	March--				April--																		
	28		29		30	1	2	5	6	8	9	11	12	15	16	17	19	20	22	23	24	26	
	a	28	29	30	1	2	5	6	8	9	11	12	15	16	17	19	20	22	23	24	26		
Diseased-----				390	250	210	210	260	120	130	180	140	130	200	180	120	180	220	160	180	200	203	140
Badly diseased-----				430	300	280	290	290	210	180	140	230	180	250	250	230	130	240	270	280	340	260	200
Disease-free-----				430	340	280	240	250	130	180	90	220	270	220	220	160	230	220	230	200	260	290	170
Average-----				417	297	257	247	267	153	163	137	197	193	223	217	170	197	227	220	220	267	251	153

a Check test.

The data on relative humidity were obtained from the division of soil physics, College of Agriculture, University of Illinois. In this division daily relative humidity readings are taken at 7 a. m., 2 p. m., and 7 p. m. My heating tests were not made coincident with the observed readings, but the nearest humidity reading was taken as the one to be graphed. Thus, if the corn was tested at 3 p. m. on April 2, the relative humidity reading taken on that day at 2 p. m. was the one used.

In fig. 4 the broken line indicates the relative humidity, and the solid line the average of the total germinations. It was found, upon graphing the germination totals for each type of corn separately, that no type followed the changes in relative

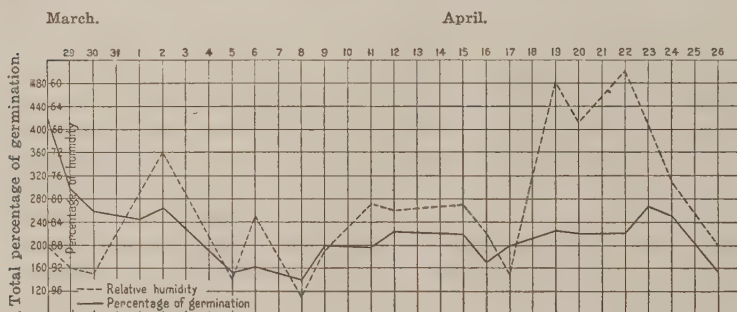


FIG. 4. Graph showing daily variation in percentage of germination and relative humidity.

humidity more closely than another. For the sake of clearness, therefore, the totals for the three types were averaged and the graph made from these data. The variation of the three types followed that of the relative humidity closely where the changes were great and continued for several days, such as the great drop from April 2 to 5 and that from April 23 to 26; but where the changes were smaller and less prolonged, as April 11 and 12, one type might follow the change in relative humidity while the other two types might vary in the opposite direction, or vice versa.

It would not be justifiable, from the data at hand, to say that one type varies more widely or more rapidly under outdoor conditions than another; but it can be said that with few exceptions the average resistance to heat, of corn stored in the open, varies inversely to the changes in relative humidity of the atmosphere. Where the curves do not coincide the differences are not great and could probably be explained by a wide change in humidity

before the test was made or, more probably, by the moisture content of the corn lagging behind the changes in relative humidity of the atmosphere.

The germination totals of Diseased were low; those of Disease-free, high; and those of Badly diseased, intermediate. This relation held rather consistently throughout the entire test.

A graph of the average total plumule lengths varied more widely than did that of the percentages of germination and, while following in the main the changes in relative humidity, did not follow as closely as did that of the percentages of germination; hence it was not included in fig. 4.

A moisture determination was made on April 26, at the time the test was made. The day was warm and humid, and the kernels of corn while being handled fell on the table with a dull thud. From the graph we see that the humidity was low, but not the lowest reached during the test. The moisture determinations were as follows: Diseased, 14.86 per cent; Badly diseased, 14.60 per cent; Disease-free, 14.44 per cent. This bears out the statement that Diseased, in the air-dry condition, contains the most moisture and Badly diseased and Disease-free lesser amounts, in the order named. The average total germination on that day was one of the lowest in the table.

PLACING IN WATER AFTER HEATING

Just (1875), in working with seeds of *Trifolium pratense*, said that seeds heated at 100° C. germinated if after heating they were supplied with water slowly, but did not germinate if supplied with water rapidly. An extensive series of experiments was undertaken to see if placing in water immediately after heating to high temperatures had any effect on the germination of corn, and further, to learn if the sudden intake of water and the sudden cooling injured the viability of the kernels.

The corn was heated in phials in duplicate sets and immediately after heating, while the phials were still hot, the corn from one set was placed in tap water at room temperature, while the corn from the other set was placed in aluminum dishes to cool. After the first set had soaked four hours it was taken out and placed between moist blotting paper, to prevent drying out, and the second set soaked four hours; thus each set was soaked for an equal period of time. At the end of the second four hours both sets were placed in rag dolls and these placed in the germinator jars as usual. Two trials were made, in-

volving air-dry corn heated at 80° and at 90° C., and corn which had been desiccated nineteen days, heated at 100° C. The entire result is summarized in Table 19. Air-dry corn was averaged separately from desiccated, to determine any difference in resistance.

TABLE 19.—*Effect of placing corn in water immediately after heating.*

[W, corn placed in water immediately after cooling; A, corn placed in aluminum dishes to cool.]

Type of corn.	First trial.				Second trial.			
	Air-dry.		Desiccated.		Air-dry.		Desiccated.	
	W	A	W	A	W	A	W	A
Diseased.....per cent.	91.7	86.6	87.7	91.1	56.7	53.3	81.8	71.0
Badly diseased.....do.	93.3	88.3	53.9	51.4	60.0	58.3	46.7	51.7
Disease-free.....do.	90.6	85.0	58.3	63.3	46.7	53.3	49.2	46.7
Average.....	91.9	86.6	66.6	68.6	54.5	55.0	59.2	56.5
Average length of plumule.....mm.	113.0	118.4	72.2	27.6	72.8	53.4	72.3	83.5

From Table 19 it is evident that there is no consistent variation due to placing the corn in water after heating. In the first trial, in air-dry corn, the germination was best in that placed in water immediately after cooling and the plumule length was least. In desiccated corn, the germination was best in that placed in aluminum dishes to cool and the length of plumule was least. This is exactly reversed in the second trial. The differences, moreover, were not large. It can be said, therefore, that placing corn in water immediately after heating has no effect whatever on either the percentage of germination or on the length of plumule.

GROWTH OF HEATED CORN IN SOIL

To determine the effect of heating the kernels upon the germination of corn in soil and the subsequent growth and the green weight of the seedling, corn of the three types was heated and then planted in rows, in garden loam in a bench in the middle of the greenhouse, equally lighted and heated from all sides. Air-dry corn was heated at 80° C. for 5, 7.5, 10, 12.5, and 15 minutes and was planted 0.75 inch deep. Corn that had been in the desiccator for 16 days was heated at 90° C. for 110, 130, 140, and 150 minutes and was planted the same way. Checks of each were also planted. Ten kernels of each type were used for each period of heating.

There was a noticeable retardation in the germination and growth of corn heated most severely, in both the air-dry and

the desiccated lots. In digging up the kernels many were found to have put out a short plumule or radicle, but they did not have growth energy enough to force their way to the surface. This probably accounts for much of the difference between the results obtained in rag dolls and the result obtained in the soil, for the germination in rag dolls was 60 per cent and in soil, 27.8 per cent, in a series using air-dry corn heated at 80° C. Records were taken of the time of appearance of the shoots above the soil, and height measurements were taken at the end of thirty days, at which time the plants were harvested by cutting off the stalk at the surface of the soil, and the green weight was taken. The results of the above planting are recorded in Tables 20 and 21.

TABLE 20.—*Growth of air-dry corn heated at 80° C., and planted in soil.*

Treatment.	Type of corn.	Germination.	Total green weight.	Average green weight per plant.	Height per plant.
		<i>Per cent.</i>	<i>g.</i>	<i>g.</i>	<i>cm.</i>
Check.....	Diseased.....	100	47.85	4.785	59
Do.....	Badly diseased.....	100	37.65	3.765	59
Do.....	Disease-free.....	90	40.25	4.472	56
Heated 5 minutes.....	Diseased.....	100	43.00	4.300	62
Do.....	Badly diseased.....	70	23.10	3.300	55
Do.....	Disease-free.....	90	41.97	4.663	57
Heated 7.5 minutes.....	Diseased.....	100	40.10	4.010	54
Do.....	Badly diseased.....	70	31.23	4.461	52
Do.....	Disease-free.....	100	55.97	5.597	64
Heated 10 minutes.....	Diseased.....	60	6.95	1.158	30
Do.....	Badly diseased.....	60	29.32	4.887	61
Do.....	Disease-free.....	60	14.98	2.497	43
Heated 12.5 minutes.....	Diseased.....	10	0.81	0.810	28
Do.....	Badly diseased.....	10	0.52	0.520	24
Do.....	Disease-free.....	30	7.65	2.550	37
Heated 15 minutes.....	Diseased.....	0	0	0	0
Do.....	Badly diseased.....	0	0	0	0
Do.....	Disease-free.....	0	0	0	0
Average.....	Diseased.....	67.5	22.72	2.570	43.5
Do.....	Badly diseased.....	52.5	21.04	3.292	48.0
Do.....	Disease-free.....	70.0	30.14	3.827	50.3

In the air-dry corn (Table 20) no germination resulted after the 12.5-minute heating. Disease-free corn consistently had a higher percentage of germination, total green weight, average green weight per plant, and height. Badly diseased varied widely, being high in average green weight per plant and height per plant, but low in germination and total green weight. This was probably due to the fact that Badly diseased frequently

had a few highly resistant kernels which produced large plants. This is even more noticeable in Table 21 where, at temperatures that killed practically all the kernels, Badly diseased occasionally sent up a fairly vigorous seedling. The inherent weakness of Badly diseased is shown by its low germination. Diseased was high in germination and in total green weight, but low in average green weight per plant and height per plant.

TABLE 21.—Growth of corn which had been desiccated for 16 days, heated at 90° C., and planted in soil.

Treatment.	Type of corn.	Germination.	Total green weight.	Average green weight per plant.	Height per plant.
		<i>Per cent.</i>	<i>g.</i>	<i>g.</i>	<i>cm.</i>
Check.....	Diseased.....	100	39.70	3.970	53
Do.....	Badly diseased.....	80	29.35	3.670	49
Do.....	Disease-free.....	100	39.25	4.242	51
Heated 110 minutes.....	Diseased.....	70	16.95	2.421	43
Do.....	Badly diseased.....	10	2.00	2.000	40
Do.....	Disease-free.....	0	0	0	0
Heated 120 minutes.....	Diseased.....	90	33.10	3.678	48
Do.....	Badly diseased.....	0	0	0	0
Do.....	Disease-free.....	0	0	0	0
Heated 130 minutes.....	Diseased.....	60	10.00	1.667	34
Do.....	Badly diseased.....	10	0.47	0.470	21
Do.....	Disease-free.....	0	0	0	0
Heated 140 minutes.....	Diseased.....	60	9.80	1.633	30
Do.....	Badly diseased.....	0	0	0	0
Do.....	Disease-free.....	10	3.00	3.000	43
Heated 150 minutes.....	Diseased.....	70	14.90	2.129	38
Do.....	Badly diseased.....	0	0	0	0
Do.....	Disease-free.....	0	0	0	0
Average.....	Diseased.....	70.0	16.95	* 2.764	* 38.6
Do.....	Badly diseased.....	4.0	4.92	* 1.235	* 30.5
Do.....	Disease-free.....	2.0	.60	* 3.000	* 43.0

* Average of those plants that grew.

Table 21. shows the reverse of Table 20. It is an extreme example of the superior resistance to heat of Diseased corn after desiccation. This is shown especially in the percentage of germination. An occasional resistant kernel, especially in Badly diseased, but also in Disease-free, sent up a seedling even after severe heat treatment of the kernels; Diseased, however, shows remarkable germination throughout. The average height per plant was much greater in Disease-free, and the averages of the plants that grew are the following: Diseased, 38.6 centimeters; Badly diseased, 30.5 centimeters; Disease-free, 43 centimeters. The same ratio holds in green weight per plant.

CONCLUSIONS

1. Air-dry corn, containing 10 to 11 per cent moisture, is killed by exposure to 80° and 90° C. for 25 and 10 minutes, respectively, and is injured by exposure to 70°, 80°, and 90° C. for 80, 10, and 5 minutes, respectively.

2. The resistance of corn to high temperatures varies inversely as its water content at the time of heating.

3. Under air-dry conditions, Diseased corn contains the most moisture, Disease-free the least moisture, and Badly diseased an intermediate amount. Their resistance to heat is inversely proportional to their moisture content.

4. After desiccation over sulphuric acid Diseased corn contains the least moisture, Disease-free the most moisture, and Badly diseased an intermediate amount.

5. After desiccation Diseased corn is very much more resistant to heat, compared with Disease-free and Badly diseased corn, than its slightly less moisture content would indicate. This greater resistance becomes evident only as the temperatures become injurious.

6. After desiccation, Diseased corn is most resistant to heat, Disease-free less resistant, and Badly diseased is least resistant in spite of its moisture content being less than that of Disease-free corn. The last difference may be explained by the superior vigor of Disease-free and the diseased and weakened condition of Badly diseased.

7. Desiccation brings about changes in the corn that cause Diseased to become very resistant to heat, and Badly diseased to become less resistant. What these changes are is not known.

8. Desiccation over sulphuric acid in a closed vessel is not uniform; it is greatest farthest from the surface of the acid, and least closest to it. This gradient gradually lessens as the length of time of desiccation increases.

9. The resistance to heat of air-dry corn, both in the laboratory and outdoors, varies with the variations in climatic conditions (humidity). The three kinds of corn tested vary in a similar manner.

10. Placing the heated corn in water immediately after treatment has no injurious effect on its viability.

11. Germination of heated corn is better in rag dolls than in soil.

12. Amount of growth of the seedlings follows, in general, the percentage of germination of the treated and untreated corn.

13. The percentages of germination, green weight, and height of plants of heated corn grown in soil parallel the behavior shown in germination in the rag dolls. In air-dry corn Disease-free is consistently highest, Diseased lowest, and Badly diseased intermediate. In desiccated corn Diseased is consistently highest, Disease-free usually lowest, and Badly diseased varies between lowest and intermediate.

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ILLUSTRATIONS

PLATE 1

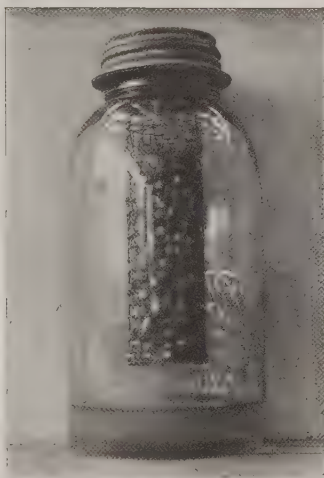
- FIG. 1. Germination jar.
2. Desiccator jar.
3. Rag doll wrapped on wire core.
4. Apparatus used in heating the corn.

TEXT FIGURES

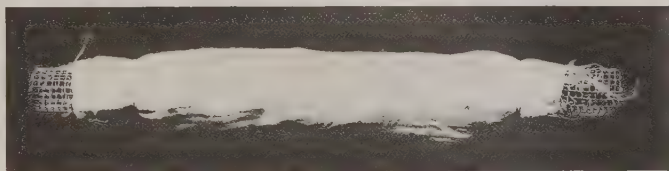
- FIG. 1. Graph showing difference in percentage of germination between Diseased and Disease-free corn and between Badly diseased and Disease-free corn, after desiccation and heat treatment.
2. Graph comparing the moisture content of the three types of corn, air-dry and after varying lengths of time in the desiccator.
3. Graph showing the frequency with which the different types of corn, after varying lengths of time in the desiccator, contained the least, the most, and medium amounts of moisture; based on fifteen determinations.
4. Graph showing daily variation in percentage of germination and relative humidity.



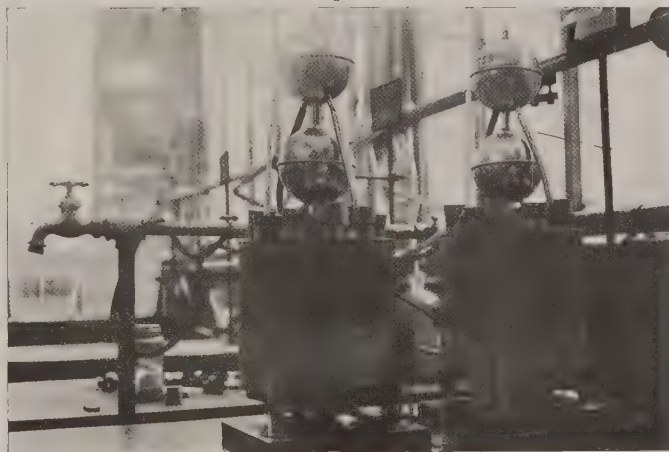
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PLATE I.

NEW SPECIES OF MELOLONTHID BEETLES FROM THE PHILIPPINE ISLANDS

By J. MOSER

Ellrich im Harz, Germany

Neoserica opacula sp. nov.

♂. *N. luzonicae* Mos. similis, femoribus tibiis que posticis paulo latioribus. Opaca, supra nigro-fusca, subtus rufo-fusca. Capite, fronte opaca, clypeo subrugoso, margine antico elevato, leviter sinuato; antennis rufoflavis, flabello maris 4-articulato, stipiti longitudine fere aequali; prothorace postice duplo latiore quam longiore, antrorsum angustato, lateribus curvatis, ciliatis, angulis anticis acutis, porrectis, angulis posticis obtusis, rotundatis, margine antico medio leviter producto, dorso subtiliter punctato; elytris seriato-punctatis, interstitiis paulo convexis, sparsim punctis obtectis; pygidio sat remote umbilicato-punctato, punctis minutissime setosis. Subtus pectore utrinque juxta medium erecte setoso, pectoris lateribus coxisque posticis umbilicato-punctatis, coxis juxta latera setis instructis; abdominis segmentis transversim setosis; femoribus posticis sat latis, opacis, ante marginem posticum setis nonnullis sat validis vestitis, margine postico in parte apicali sinuato; tibiis posticis dilatatis et abbreviatis. Long. 8.5 mm.

SIBUYAN (*C. F. Baker*).

Apogonia imugana sp. nov.

Oblonga, postice parum modo ampliata, nigra, nitida, cupreo-micans. Capite, fronte sat remote subtiliter, clypeo fortiter subrugoso-punctato, clypei margine antico late sinuato, angulis rotundatis; prothorace transverso, lateribus fortiter curvatis, angulis anticis fere rectangulis, perparum modo productis, angulis posticis rotundatis, dorso medio sparsim, juxta latera paulo densius subtiliter punctato; scutello lax subtilissime punctato; elytris dorso subtiliter punctatis, juxta latera transversim rugosis, costis indistinctis, sparsim punctis obtectis; pygidio rugoso-punctato, erecte griseo-piloso. Subtus pectoris medio parce, abdominis medio densius punctato, pectoris abdominisque

lateribus confertim punctis griseo-setosis instructis; abdominis lateribus haud carinatis; pedibus gracilibus, tibiis anticis tridentatis. Long. 12 ad 13 mm.

LUZON, Nueva Vizcaya Province, Imugan (*G. Boettcher*) V. 1916.

Apogonia callosifrons sp. nov.

♂. Oblongo-ovalis, subopaca, nigro-fusca, paulo cuprascens. Capite mediocriter dense punctato, clypei basi carinata, clypei margine antico late rotundato, medio subsinuato, fronte post carinam bicallosa; prothorace transverso, medio rotundato-dilatato, angulis anticis acutis, productis, angulis posticis obtusis, subrotundatis, dorso mediocriter crebre punctato; elytris leviter rugosis, sat remote punctatis, costis valde indistinctis; pygidio parce punctato, postice erecte piloso. Subtus pectoris medio subtiliter, pectoris lateribus coxisque posticis fortius punctatis, abdomine mediocriter dense punctis oblecto, abdominis lateribus haud carinatis; pedibus posticis gracilibus, tibiis anticis tridentatis. Long. 12 mm.

LUZON, Nueva Vizcaya Province, Imugan (*Baker*).

Apogonia banosana sp. nov.

♂. *A. palawanae* Heller similis, praecipue differt; tibiis anticis bidentatis. Nigra, nitida, paulo cupreo-micans. Capite, fronte remote, clypeo dense punctato, clypei margine antico late rotundato; antennis fulvis; prothorace fere clypeo latiore quam longiore, lateribus leviter curvatis, angulis anticis fere rectangulis, parum productis, angulis posticis rotundatis, dorso mediocriter crebre punctato; scutello punctis nonnullis instructo; elytris sat remote punctatis, costis fere planis; pygidio corporeque infra parce, pectoris lateribus paulo densius, punctatis, abdominis lateribus haud carinatis; femoribus posticis angustis, tarsis fuscis. Long. 7 mm.

LUZON, Laguna Province, Los Baños (*Baker*).

Apogonia tangelolana sp. nov.

♂. Oblongo-ovalis, nitida, supra nigro-fusca, subtus fusca. Capite sat dense punctato, clypeo antrorsum angustato, margine antico leviter sinuato, angulis anticis rotundatis; antennis flavo-testaceis; prothorace duplo latiore quam longiore, paulo post medium rotundato-dilatato, angulis anticis et posticis obtusis, illis haud productis, dorso sat crebre punctato; scutello fere laevi; elytris subrugoso-punctatis, costis parum distinctis; pygidio parce punctato. Subtus pectoris medio fere impunctato,

pectoris lateribus dense punctis griseo-setosis obtectis; abdomine medio parce, juxta latera paula densius punctato, punctis setis minutis vestitis, abdominis lateribus carinatis; femoribus rufo-fuscis, posticis ante marginem posticum setosis; tibiis anticis bidentatis, tarsis anticis et mediis in mare dilatatis. Long. 6 mm.

MINDANAO, Bukidnon Province, Tangcolan (*Baker*).

Apogonia latitarsis sp. nov.

♂. Oblongo-ovalis, nitida, supra viridi-fusca, subtus fusca. Capite sat dense punctato, clypeo producto, antrorsum angustato, margine antico sinuato, angulis acutis; antennis flavo-testaceis; prothorace latiore quam longiore, lateribus fortiter curvatis, angulis anticis fere rectangulis, angulis posticis obtusis, dorso subtiliter punctato; scutello laevi; elytris seriato-punctatis, interstitiis paulo convexis, fere laevibus; pygidio fortiter punctato, punctis griseo-squamoso-setosis. Corpore infra griseo-squamoso, abdominis lateribus haud carinatis, femoribus posticis sat latis, tibiis anticis bidentatis, tarsis anticis et mediis in mare fortiter dilatatis. Long. 6.5 mm.

MINDANAO, Surigao Province, Surigao (*Baker*).

Apogonia benguetana sp. nov.

A. monticolae Mos. similis, supra paulo densius punctato. Nigra, subtus nigro-fusca. Capite, fronte mediocriter crebre clypeo densius punctato, clypei margine antico rotundato; antennis fulvis; prothorace duplo latiore quam longiore, post medium rotundato-dilatato, angulis anticis fere rectangulis, angulis posticis obtusis, dorso sat crebre punctato; scutello laevi; elytris sat dense fortiter punctatis, costis laevibus; pygidio grosse punctato, punctis griseo-pilosis. Subtus parce punctato, punctis setis griseis vestitis, abdominis lateribus carinatis; pedibus gracilibus, tibiis anticis acute tridentatis. Long. 7 ad 8 mm.

LUZON, Benguet (*Boettcher*) V. 1914.

Apogonia nigripennis sp. nov.

Parva, ovalis, rufa, nitida, fronte elytrisque nigris. Capite mediocriter crebre punctato, clypei margine antico elevato, late subrotundato; prothorace longitudine plus duplo latiore, lateribus fortiter curvatis, angulis anticis paulo productis, angulis posticis rotundatis, dorso sat dense punctato; scutello parce punctulato; elytris sat crebre punctatis, costa prima postice dilatata; pygidio plano, sat remote punctato, punctis brevissime

setosis. Subtus medio parce, juxta latera densius punctato, punctis setis minutis griseis instructis, abdominis lateribus haud carinatis; tibiis anticis tridentatis. Long. 6 mm.

MINDANAO, Kolambugan (*Baker*).

Apogonia polisana sp. nov.

♂. Oblongo, rufo-fusca, nitida. Capite rugoso-punctato, clypeo antrorsum angustato, lateribus subsinuatis, margine antico paulo reflexo, truncato, levissime sinuato, angulis anticis rotundatis; antennis ferrugineis; prothorace transverso, medio rotundato-dilatato, angulis anticis productis, parum acutis, angulis posticis obtusis, subrotundatis, dorso mediocriter crebre punctato; scutello laevi; elytris levissime rugosis, costis parce, interstitiis densius punctatis, costa prima postice dilatata; pygidio grosse rugoso-punctato, punctis pilosis. Subtus medio parce, juxta latera sat dense punctato, punctis griseo-setosis, abdominis lateribus carinatis; pedibus gracilibus, tibiis anticis bidentatis. Long. 9 mm.

LUZON, Mountain Province, Mount Polis (*Boettcher*) II. 1917.

Apogonia surigaoana sp. nov.

A. viridimicanti Mos. similis, differt clypeo maris fortiter producto, margine antico sinuato, angulis acutis. Rufo-flava, nitida. Capite mediocriter crebre punctato; prothorace dimidia parte latiore quam longiore, lateribus fortiter curvatis, angulis anticis fere rectangulis, perparum productis, angulis posticis rotundatis, dorso mediocriter dense punctato; scutello fere laevi; elytris subrugoso-punctatis, costis sublaevibus; pygidio fortiter punctato, punctis pilosis. Subtus medio laxe, ad latera versus densius punctata, punctis albo-squamosis, abdominis lateribus haud carinatis; femoribus posticis remote squamis albis vestitis, tibiis anticis bidentatis. Long. 5 mm.

MINDANAO, Surigao (*Baker*).

Apogonia maculipennis sp. nov.

Oblongo-ovalis, viridi-fusca, nitida, elytris pygidioque flavis, viridi-fusco-maculatis, pedibus rufis. Capite dense punctato, clypeo antrorsum angustato, margine antico truncato, levissime sinuato, angulis anticis rotundatis; antennis ferrugineis; prothorace duplo latiore quam longiore, medio rotundato-dilatato, angulis anticis acutis, productis, angulis posticis obtusis, dorso mediocriter crebre subtiliter punctato; scutello juxta latera sub-

tilissime punctulato; elytris leviter rugosis, mediocriter crebre et irregulariter punctatis, flavis, maculis numerosis, subseriatim positis, viridifuscis; pygidio alutaceo, pilifero-punctato, medio longitudinaliter carinato. Subtus medio sat remote, juxta latera densius punctato, punctis pilosis, pectoris medio longitudinaliter sulcato, abdominis lateribus haud carinatis, tibiis anticis tridentatis. Long. 8 mm.

LUZON, Mountain Province, Pauai (Haight's place) (*Boettcher*) III. 1916.

Apogonia angustipes sp. nov.

Oblongo, postice paulo dilatata, fusca, nitida, griseo-pilosa. Capite pilifero-punctato, clypeo margine antico paulo reflexo, late rotundato, sutura clypeali impressa, bisinuata, clypeo ante carinam leviter convexo; antennis ferrugineis; prothorace transverso, medio rotundato-dilatato, angulis anticis productis, acutis, angulis posticis rotundatis, dorso sat dense punctato, punctis pilis suberectis vestitis; scutello crebre pilifero-punctato; elytris leviter rugosis, mediocriter dense punctatis, punctis suberecte pilosis, costis convexis; pygidio pilifero-punctato, pilis erectis, pygidii medio levissime longitudinaliter sulcato. Subtus sat dense punctato, punctis pilosis, pectoris medio sulco instructo, abdominis lateribus haud carinatis; pedibus gracilibus, tibiis anticis tridentatis. Long. 14 mm.

LUZON, Mountain Province, Pauai (Haight's place) (*Boettcher*) III. 1917.

Apogonia philochlaenioides sp. nov.

♂. Oblongo-ovalis, cuprea, nitida, paulo aeneo-micans, griseo-pilosa. Capite dense punctato, punctis erecte pilosis, clypeo antrorsum angustato, margine antico reflexo, leviter sinuato, angulis anticis rotundatis; antennis ferrugineis; prothorace longitudine plus duplo latiore quam longiore, lateribus curvatis, angulis anticis acutis, productis, angulis posticis obtusis, dorso sat crebre subtiliter punctato, punctis pilis erectis vestitis; scutello pilifero-punctato; elytris alutaceis, subrugoso-punctatis, punctis pilosis, pilio adpressis vel erectis, maculis numerosis glabris, tuberculiformibus, costis indistinctis; pygidio rugoso, erecte piloso. Subtus mediocriter dense pilifero-punctato, abdominis lateribus carinatis; tibiis anticis tridentatis dente primo minuto. Long. 7 mm.

LUZON, Mountain Province, Balbalasang (*Boettcher*) III. 1918.

Apogonia griseosquamosa sp. nov.

Oblongo-ovalis, fusca, paulo cuprascens, griseo-squamosa. Capite dense punctato, punctis squamosis, fronte viridisciente, clypeo margine antico paulo elevato, truncato, subsinuato, angulis rotundatis; antennis testaceis; prothorace longitudine fere duplo latiore, lateribus curvatis, angulis anticis productis, acutis, angulis posticis obtusis, dorso dense semiannulato-punctato, punctis squamis ovatis vestitis; scutello squamifero-punctato; elytris sat crebre squamis ovalibus obiectis, costis indistinctis; pygidio rugoso-punctato, punctis erecte pilosis, in pygidii parte basali squamosis. Subtus dense griseo-squamosa, abdominis lateribus carinatis; tibiis anticis tridentatis. Long. 7 mm.

MINDANAO, Surigao Province, Surigao (*Boettcher*) V. 1915.

Leucopholis bakeri sp. nov.

L. irroratae Chev. similis, differt; squamis minoribus, clypei margine antico minus elevato, prothoracis lateribus ante medium paulo distinctius sinuatis, angulis anticis magis rotundatis, processu mesosternali paulo brevior, apice excepto, pilifero-punctato. Long. 22 ad 23 mm.

MINDANAO, Dapitan (*Baker*).

Leucopholis reflexa sp. nov.

♂. *L. irroratae* Chev. similis, praecipue differt; clypei margine antico obtuse triangulari, fortiter reflexo. Long. 29 ad 30 mm.

MINDANAO (*Baker*).

Holotrichia imugana sp. nov.

♂. *H. flachi* Brsk. similis, differt prothoracis angulis anticis magis productis. Fusca, opaca. Capite medio leviter longitudinaliter impresso, fronte parce subtiliter, clypeo fortius punctato, clypei margine antico paulo reflexo, sinuato, angulis rotundatis; antennarum flabello maris parvo; prothorace duplo latiore quam longiore, medio rotundato-dilatato; lateribus haud crenulatis, ante medium leviter sinuatis, angulis anticis acutis, productis, angulis posticis rotundatis, dorso remote subtiliter punctato; scutello punctis nonnullis instructo; elytris leviter costatis, sat sparsim umbilicato-punctatis, punctis minutissime setosis; pygidio parce umbilicato-punctato. Subtus pectore coxisque posticis flavido-villosis, abdominis lateribus sparsim

pilosis; articulo primo tarsorum posticorum secundo parum brevior, unguibus dente mediano armatis. Long. 28 mm.

LUZON, Nueva Vizcaya Province, Imugan (*Boettcher*) 30. I. 1916.

Holotrichia banahaoensis sp. nov.

H. flachi Brsk. similis, differt prothorace postice minus constricto. Fusca vel nigro-fusca, opaca. Capite, fronte medio-criter crebre punctato, clypeo paulo rugoso, densius punctato, clypei margine antico sinuato, angulis anticis late rotundatis; antennarum flabello in utroque sexu minuto; prothorace longitudine plus duplo latiore, medio rotundato-dilatato, lateribus integris, angulis anticis fere rectangulis, parum productis, angulis posticis subrotundatis, dorso sat remote subtiliter punctato; scutello sparsissime punctulato; elytris leviter costatis, costis fere laevibus, interstitiis umbilicato-punctatis; pygidio sparsim punctato, punctis minutissime setosis. Pectore, medio glabro excepto, flavo-piloso, abdominis lateribus pilis vestitis, articulis duobus primis tarsorum posticorum longitudine aequalibus unguibus dente mediano armatis, dente ad basim dilatatam versus inclinato. Long. 21 ad 23 mm.

LUZON, Mount Banahao (*Boettcher*) IV.-V. 1914.

Holotrichia bakeri sp. nov.

H. monticolae Mos. similis, paulo major, antennarum flabello longiore. Fusca, supra subopaca, subtus nitida, abdominis lateribus pruinosis. Capite, fronte parce, clypeo subrugoso punctato, clypeo antrorsum haud angustato, margine antico reflexo, leviter sinuato, angulis anticis rotundatis; antennis rufo-fuscis, flabello maris articulis 6 praecedentibus compositis longitudine aequali, flabello feminae brevior; prothorace transverso, medio rotundato-dilatato, lateribus ante medium leviter sinuatis, angulis anticis fere rectangulis, angulis posticis rotundatis, dorso subtiliter punctato, margine postico longe flavo-ciliato; scutello juxta latera punctis nonnullis minutis instructo; elytris subrugoso-punctatis, singulis tricostatis, costis sparsissime punctatis, costa tertia indistincta; pygidio sat remote punctato. Subtus pectore longe et dense flavo-piloso, abdomine medio sparsissime, juxta latera paulo densius punctato, punctis pilis vestitis; tibiis anticis tridentatis, tarsis posticis articulo primo secundo paulo brevior, unguibus basi dilatatis et dente mediano armatis. Long. 21 mm.

LUZON, Mountain Province, Baguio (*Baker*).

Microtrichia mindanaoensis sp. nov.

♂. *M. cribripenni* Brsk. simillima, differt tarsis posticis articulo primo secundo brevior. Nigro-fusca, nitida. Capite dense punctato, clypeo brevi, margine reflexo, medio sinuato; antennis ferrugineis, 10-articulatis, flabello maris rufo-flavo, articulis 6 praecedentibus conjunctis longitudine aequali; prothorace transverso, medio rotundato-dilatato, lateribus in parte anteriore leviter crenulatis, angulis anticis paulo productis, fere rectangulis, angulis posticis obtusis, dorso sat crebre irregulariter punctato; scutello, basi excepto, punctato; elytris rugoso-punctatis, singulis indistincte quadricostatis; pygidio subrugoso, annulato-punctato, margine antico opaco. Subtus minus dense punctata, medio nitido, lateribus opacis, punctis juxta pectoris abdominisque latera et segmento penultimo brevissime setosis; tibiis anticis distincte tridentatis, unguibus late fissis. Long. 12 mm.

MINDANAO, Surigao Province, Surigao (*Boettcher*) 12. V. 1915.

Hoplia bakeri Mos., Stett. Ent. Zeit. (1921) 16.

The length of this species is 6 millimeters, not 16.

Hoplia luzonica sp. nov.

H. maculifera Mos. similis, minor, prothorace ante medium minus angustato. Picea, supra dense fusco-squamulata, elytris post medium utrinque macula obscura ornatis, subtus argenteo-squamosa, pedes rufo-fusci. Variat: Corpore supra et subtus crebre argenteo-squamulato, prothoracis vittis duabus mediis elytrorumque fasciis duabus transversis reductis obscurioribus. Capite, fronte dense squamosa, parce setosa, clypeo nitida, antrosum angustato margine antico elevato, truncato; antennis piceis, 9-articulatis; prothorace latiore quam longiore, lateribus setosis, post medium profunda sinuatis, ante medium subsinuatis, angulis anticis rectangulis, angulis posticis obtusis, dorso squamis circularibus dense vestito et sparsim erecte setoso; elytris confertim squamosis, seriatim setosis; pygidio corporeque infra crebre squamis obtectis, illo sparsim erecte setoso; tibiis anticis tridentatis, unguibus omnibus fissis. Long. 4 ad 5 mm.

LUZON, Mountain Province, Baguio (*Boettcher*) III. 1917.

Hoplia griseovestita sp. nov.

♂. *H. simplici* Sharp similis, minor, elytrorum setis erectis minus crassis. Ferruginea, supra et subtus griseo-squamosa.

Capite, fronte dense squamulato et sparsim setosa, clypeo nitida, margine antico elevato, subsinuato; antennis fulvis, 9-articulatis; prothorace latiore quam longiore, antice et postice attenuato, angulis anticis fere rectangulis, angulis posticis obtusis, dorso dense squamoso, erecte setoso; elytris crebre squamis orbicularibus vestitis, setis parvis suberectis seriatim positis; pygidio confertim squamoso et sparsim setoso. Corpore infra dense squamulato, pedibus ferrugineis, minus crebre squamosis; tibiis anticis tridentatis, unguibus omnibus apice fissis. Long. 4 ad 5 mm.

MINDANAO, Surigao Province, Surigao (*Baker*).

A MONOGRAPH OF THE PACHYRRHYNCHID GROUP OF
THE BRACHYDERINÆ, CURCULIONIDÆ: PART II ¹

THE GENERA EUPACHYRRHYNCHUS, MACROCYRTUS, EUMACROCYRTUS, APOCYRTUS, PROAPOCYRTUS, PSEUDAPOCYRTUS, NOTH-
APOCYRTUS, AND EXNOTHAPOCYRTUS

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TWO PLATES

The genera treated in this part are endemic to the Philippines and are confined to a few islands of this Archipelago. The recognition of the sex of the species of these genera is of great importance for determination. For that reason I have deemed it advisable to give, on Plate 2, a representative series of lateral views of species, showing plainly the diversity in form and scale markings in both sexes in the respective species. Since the hind femora, in respect to their relative position to the apex of the elytra, offer also a very useful criterion for sex determination, they are included in the drawings in their exact position. All lateral-view drawings on Plate 2 were made with a Zeiss binocular microscope (oculars No. 1, objectives F-55) and a camera lucida. Then the drawings were reduced by means of a pantograph to one-fourth of the original size. The drawings were then completed with India ink and crayon pencil and assembled on bristol board. This plate was reproduced by means of the half-tone photo-engraving process and reduced to the present size, which is approximately twice the natural size.

Genus **EUPACHYRRHYNCHUS** Heller

Eupachyrrhynchus HELLER, Philip. Journ. Sci. § D 7 (1912) 324.

Rostrum as in *Pachyrrhynchus*, dorsoapically swollen. Scape of antennæ reaching posteriorly to posterior margin of eye. Elytra short-ovate, laterally broadened, dorsally depressed, posterior decline abrupt, particularly in the female, the apical part slightly projecting.

¹For Part I see Philip. Journ. Sci. 23 (1923) 609-673 and 24 (1924) 309-366.

This genus forms a link between *Pachyrrhynchus* and *Macrocyrtus* (subgenus *Exmacrocyrtus novum*). The prothorax laterally only with a fine anterior submarginal groove. Anterior ventral margin of prothorax distinctly emarginate. First and second abdominal sternites connate.

Type species, *Eupachyrrhynchus superbus* Heller, from the Philippine Islands.

Eupachyrrhynchus superbus Heller.

Eupachyrrhynchus superbus HELLER, Philip. Journ. Sci. § D 7 (1912) 325, pl. 2, fig. 8.

Blackish, purplish, with large scale spots which are light greenish in the central part but reddish golden around the margin. Rostrum dorsally with an oblong golden scale spot. Front between eyes fine and scatteredly punctured, in the middle with a punctiform impression. Vertex smooth. Prothorax hardly broader than long, very finely and scatteredly punctured, the greatest width before the middle. A transverse golden scale spot dorsolaterally at anterior margin, more or less confluent with a scale marking at lateral margin. Another wedge-shaped scale spot, dorsolaterally extending from the middle to the posterior margin. Elytra short-ovate, depressed, in the male posteriorly strongly declined, in the female the apical part projecting, basal half regularly striate-punctate, apical half irregularly punctate. The scaled areas of elytra larger than the bare areas, the former consisting of a golden lateral marginal stripe, which is sometimes interrupted in the basal half and apically strongly broadened, and the following scale spots which are centrally light green, marginally reddish-golden. Each elytron with two large oval subsutural spots sometimes confluent, reaching posteriorly to the middle, and a large transverse spot laterally before the middle reaching from the fourth puncture row to near the lateral margin. In apical half four smaller roundish spots and at apical third an oblong bifid sutural spot. Underside and legs glossy black, the femora with a greenish or purplish sheen. Prosternum, mesosternum, and metasternum laterally with golden scale markings. Last abdominal sternite of female with a deep groove along the margin.

Length, 13.5 to 15 millimeters; width, 7 to 7.2.

Philippine Islands (*Semper*) exact locality unknown, but I suspect that this species came from northern Luzon. Of this species I have seen only the specimen in the Dresden Museum. The above description is mainly as given by Heller.

Genus *MACROCYRTUS* Heller

Macrocyrtus HELLER,² Philip. Journ. Sci. § D 7 (1912) 331.

Rostrum distinctly longer than broad, in transverse section almost square, confluent with front, dorsally with a fine medial groovelike depression. Scape of antenna reaching beyond hind margin of eye. Eyes slightly convex. Elytra dorsally flattened, laterally rather angulately and abruptly declined, or uniformly convex dorsolaterally. Male with the last three abdominal sternites distinctly segmented, female with only the last sternite segmented, the others connate with metasternum. Tibiæ on underside with blunt tubercles distantly apart, more pronounced on posterior tibiæ.

Type species, *Macrocyrtus nigrans* Pascoe, from Luzon, Philippine Islands.

The generic characters as outlined above had to be somewhat amplified in order to include certain species which exhibit superficially a rather heterogeneous aspect, particularly in the general form of the elytra. The first, or typical, group, which has the elytra dorsally rather strongly flattened in both sexes, I designate as subgenus *Macrocyrtus*. The species of the second group have the elytra more strongly and uniformly convex dorsolaterally, particularly in the females; the elytra of the males dorsally more or less strongly convex or slightly flattened. The second group I designate as subgenus *Exmacrocyrtus* novum, to be typified by the species *M. erosus* Pascoe.

Subgenus *Macrocyrtus* sensu stricto

The subgenus *Macrocyrtus* s. str. contains the following species: *M. nigrans* Pascoe, *M. castaneus* Pascoe, *M. subcostatus* Heller, and *M. benguetanus* Schultze.

Key to the species of the subgenus *Macrocyrtus* s. str. Heller.

a¹. Elytra with distinct stripes.

b¹. Elytra with broad whitish longitudinal stripes..... *M. subcostatus* Heller.

b². Elytra with bronze green scale stripes..... *M. benguetanus* Schultze.

² Heller's original diagnosis is as follows:

"Rostrum latitudine distincti longius, sectione transversa fere quadrata a fronte haud distinctum, dorso sulco mediano tenui. Antennarum scapus margine oculari postica superans. Oculi parum convexi. Elytra plerumque dorso depressiuscula. Sternita abdominalia primo secundoque connata, femina solum sternita tres aspectabilia. Tibiæ posticae margine interno remote tuberculatae."

α^2 . Elytra uniformly colored, without distinct stripes.

c^1 . Uniform dark brown, almost black, lateral decline of elytra very abrupt..... *M. nigrans* Pascoe.

c^2 . Castaneous brown, lateral decline of elytra not abrupt, but rounded.
M. castaneus Pascoe.

Macrocyrtus (*Macrocyrtus*) *nigrans* Pascoe. Plate 1, fig. 3, ♀;
Plate 2, fig. 3, ♂, fig. 4, ♀ (lateral view).

Apocyrtus nigrans PASCOE, Cist. Ent. 2 (1881) 593.

Apocyrtus contractus CHEVROLAT, Le Natur. 3 (1881) 363.

Macrocyrtus nigrans PASCOE, Heller, Philip. Journ. Sci. § D 7 (1912)
331, pl. 1, figs. 3, 3a.

Macrocyrtus nigrans var. *castanopterus* HELLER, loc. cit.

Very dark brown, almost black. Rostrum longer than broad, dorsally flattish and in a plane with front, rather densely and irregularly punctured, with a fine medial groove extending to latter. Prothorax subcylindrical, finely punctured, the punctures dorsally more or less confluent. Traces of an anterior submarginal groove faintly indicated, the posterior submarginal groove somewhat more strongly pronounced. Elytra oblong-elliptical, depressed, broadest at or slightly before the middle; laterally abruptly declined toward the margin, the apical slope very gradual and uniform; punctate-striate, the punctures rather closely approaching each other. Suture smooth and glossy. In the male abdominal sternites 1 and 2 connate, 3 to 5 well segmented; female with all abdominal sternites connate except the last, which is laterally strongly depressed, forming a triangular swelling in the middle. Hind femora in the male longer, in both sexes not reaching to apex of elytra. Penis structure, Plate 2, fig. 35.

Male, length, 14 to 15 millimeters (without rostrum); width, 5.5 to 5.8. Female, length, 14 to 16 millimeters (without rostrum); width, 5.6 to 7.3.

LUZON, Benguet Subprovince, Baguio, Irisan, mountain trail to rest house, kilometer 88 (*Curran*; *McGregor*; *Schultze*).

The general coloration and the sculpture of this species are rather variable; the color ranges from castaneous brown to almost black. In the var. *castanopterus* Heller the color is castaneous brown, the legs are reddish brown, except apex of femora and tarsi, which are black.

Macrocyrtus (*Macrocyrtus*) *castaneus* Pascoe. Plate 2, fig. 11, ♂,
fig. 12, ♀ (lateral view).

Apocyrtus castaneus PASCOE, Cist. Ent. 2 (1881) 591.

Macrocyrtus castaneus PASCOE, Heller, Philip. Journ. Sci. § D 7
(1912) 331.

Castaneous brown. Very closely related to *Macrocyrtus nigrans* Pascoe. Rostrum irregularly punctured, with an indistinct medial groove reaching to front. Prothorax subcylindrical, irregularly densely punctured, beset with very minutely fine hair arising from the punctures. Some specimens with small irregular patches of creamy white hairlike scales, located dorsolaterally and at lateral margin. Elytra oblong-ovate, in the male very slender in build, much more so than in *M. nigrans*. The lateral decline of elytra not so abrupt as in the latter, but more rounded, the suture smooth and glossy, densely and irregularly striate-punctate, almost finely rugose and also beset with minutely fine hair. In the female, each elytron mostly with three faintly indicated narrow longitudinal ridges, along the lateral marginal one of which are a few scattered whitish hairlike scales. Mesosternum and metasternum laterally also with a small patch of these scales.

Male, length, 12.5 to 15.5 millimeters (without rostrum); width, 4.5 to 5.5. Female, length, 14.3 to 14.6 millimeters (without rostrum); width, 5.6 to 6.

LUZON, Benguet Subprovince, Mount Santo Tomas (*Schultze*); Mount Pulog (*McGregor*; *Curran*).

In this species the sculpture is also very variable. The species seems to be confined to the higher mountain ranges of Benguet Subprovince.

Macrocyrtus (*Macrocyrtus*) *subcostatus* Heller. Plate 1, fig. 2, ♂.

Macrocyrtus subcostatus HELLER, Philip. Journ. Sci. § D 7 (1912) 332, pl. 2, fig. 5; SCHULTZE, Philip. Journ. Sci. 21 (1922) 594, pl. 4, fig. 19.

Piceous; prothorax and elytra with grayish white markings formed by short scalelike hair. Rostrum longer than broad, coarsely and confluent punctured toward apex, the punctures smaller and scarcer toward base and front. An oblong longitudinal shallow depression on rostrum continued as a medial groove to front. Antennæ relatively much longer than in *Macrocyrtus nigrans* Pascoe. Prothorax longer than broad, the lateral margins slightly convergent toward anterior margin, densely and irregularly punctured and beset with fine whitish scalelike hairs, which form more or less indistinct spots dorsolaterally near anterior and posterior margins and at lateral margins. Elytra oblong-elliptical, dorsally strongly flattened, the lateral margins abruptly declined, coriaceous. Each elytron dorsally with four more or less pronounced longitudinal ridges (sutural ridge included), which become obsolete at apical fourth.

Between the ridges three broad, shallow depressions, each with two irregular rows of coarse punctures and beset with white scalelike hair, thus forming longitudinal stripes. Lateral margins also closely beset with fine white hair. Apical sutural terminations of elytra in the male evenly rounded, in female with a very small triangular excision. Legs; femora and tibiæ reddish brown, blackish near apex, tarsi also black. Underside of tibiæ setose and beset with a few small tubercles, which are more pronounced on the hind tibiæ in the male. Penis structure, Plate 2, fig. 36.

Male, length, 15.5 to 21.8 millimeters (without rostrum); width, 6 to 9. Female, length, 18 to 19 millimeters (without rostrum); width, 7.8 to 8.5.

LUZON, Benguet Subprovince, Mount Pulog (*McGregor*); Mount Santo Tomas (*Schultze*); Mount Bowdan and Mount Puloloko (*Ramos*); Pauai (Haight's place) (*Schultze*); Suyoc (*Zschokke*).

This species is rather widely distributed in the mountain ranges of northern Luzon, but is found mostly at altitudes of about 2,000 meters.

Macrocyrtus (*Macrocyrtus*) *benguetanus* Schultze.

Macrocyrtus ? *benguetanus* SCHULTZE, Philip. Journ. Sci. § D 12 (1917) 255, pl. 1, fig. 8, ♀.

Macrocyrtus benguetanus var. *montanus* SCHULTZE, loc. cit., pl. 1, fig. 9, ♂.

Very dark brown; head, prothorax, and elytra with bronze green scale markings. Rostrum shagreened and irregularly punctured, fine hair arising from the punctures. A moderate, longitudinal depression, which is continued between eyes as a fine groove to vertex. The punctured areas of rostrum and front with scattered bronze green scales. Antennæ beset with fine white hair, first funicular joint the longest, second almost as long as first, the following short, each about one-third the length of second joint. Prothorax sparsely punctured, with a prominent longitudinal median groove and a rather indistinct anterior submarginal groove. Punctuation in female obsolescent. A broad bronze green dorsolateral stripe reaching from anterior to posterior margin interrupted before the middle, thus forming a roundish spot at anterior margin. Another broad stripe at lateral margins. Elytra strongly but irregularly punctate-striate. Each elytron with three irregular, longitudinal stripes, two of which are dorsolateral, the other stripe at lateral margin. These stripes are irregularly interrupted before and

behind the middle, forming irregular spots, the basal and apical spots the largest. Elytra with some fine, scattered hair, particularly at the margins apically. Legs reddish brown, finely setose. Underside of fore tibiae with fine tubercles or blunt teeth. Apical ends of elytra of male rounded, those of female suturally acutely divergent, forming a triangular excision.

Male, length, 10 millimeters (without rostrum); width, 3.5. Female, length, 12 millimeters (without rostrum); width, 5.

LUZON, Benguet Subprovince, Mount Santo Tomas, 2,250 meters (*Schultze*).

Macrocyrtus benguetanus var. *montanus* Schultze.

Castaneous brown. Rostrum with the longitudinal depression less pronounced than in the typical form. Prothorax with the longitudinal median groove very indistinct, almost obsolete. The stripes very broad, especially on elytra. Legs red, apical half of femora and tarsi dark brown.

LUZON, Benguet Subprovince, Pauai (Haight's place), 2,700 meters, and near rest house at kilometer 88 (*Schultze*).

Subgenus *Exmacrocyrtus* novum

General form of elytra in the male oblong-oval or elliptical, more or less strongly convex; in the female the elytra broader, more convex than in the male, the apical part forming a short projection with a distinct triangular sutural excision at apex. This subgenus contains the following species: *Exmacrocyrtus erosus* Pascoe, *E. erosus* var. *impressimaculatus* var. nov., *E. pseudopolitus* Heller, *E. negrito* Heller, *E. hieroglyphicus* Schultze, *E. trivittatus* Schultze, *E. kalinganus* Schultze, *E. multipunctatus* Schultze, and *E. ilocanus* Schultze.

Key to the species of the subgenus *Exmacrocyrtus* novum.

a¹. With well-defined scale markings, ring markings, spots, or stripes.

b¹. Elytra with spots or stripes.

b². Elytra with white, narrow, elongate ring markings.

M. erosus Pascoe.

c¹. With spots.

d¹. With large spots.

d². With numerous small spots..... *M. multipunctatus* Schultze.

e¹. With large brilliant oval spots..... *M. kalinganus* Schultze.

e². Elytra with irregular pale greenish white spots.

M. ilocanus Schultze.

c². With stripes.

f¹. Elytra with six regular longitudinal stripes.

M. trivittatus Schultze.

f². Elytra with eight more or less wavy stripes.

M. hieroglyphicus Schultze.

α^2 . With ill-defined scale markings or without any.

g^1 . Elytra with or without some bluish or greenish marbled scale patches.

M. negrito Heller.

g^2 . Glossy black, elytra near apex with a few rudimentary greenish scales.

M. pseudopolitus Heller.

g^3 . Glossy black, elytra with slightly impressed grayish rudimentary spots, sometimes only traces..... *M. erosus* var. *impressimaculatus* nov.

Macrocyrtus (*Exmacrocyrtus*) *erosus* Pascoe. Plate 1, fig. 6, ♀ ; Plate 2, fig. 1, ♂, fig. 2, ♀ (lateral view).

Apocyrtus erosus PASCOE,³ Journ. Linn. Soc. London 11 (1873) 156.

Pachyrrhynchus impressipennis CHEVROLAT, Le Natur. 3 (1881) 348.

Macrocyrtus erosus HELLER, Philip. Journ. Sci. § D 7 (1912) 331;

SCHULTZE, Cat. Philip. Col. (1915) 135; Philip. Journ. Sci. 21 (1922) 593, pl. 4, fig. 18.

Glossy black, elytra with variable narrow, white scale-stripe markings forming shorter or longer oblong loops. Rostrum sparsely and irregularly punctured, with an oblong medial depression and a fine medial groove reaching to the front, at the base an indistinct transverse depression. Prothorax subcylindrical, longer than broad, finely and scatteredly punctate, with an indistinct anterior groove and a distinct posterior submarginal groove. Along anterior margin and at lateral margin some irregularly scattered scales. Elytra in the male oblong-ovate, uniformly sloping toward apex, apical sutural terminations evenly rounded; in the female broad-ovate, at apical fourth rather abruptly sloping, the apical part forming a short projection, the apical sutural terminations of elytra with a triangular excision. Elytra in both sexes striate-punctate and with shorter or longer oblong narrow white scale stripes forming loops, located in shallow groovelike depressions. These markings vary individually; in some instances they extend from near base to apical slope; in others they are interrupted, forming longitudinal series of shorter or longer ring markings. The

³ The original Pascoe description, which seems to refer to a small male, is as follows:

"*Apocyrtus erosus* A. niger, nitidissimus, subtus et in capite prothoraceque fere omnino glaber; rostro supra haud excavato, in medio longitudinaliter sulcato, sulco transverso obsoleto; prothorace subcylindrico; elytris ad latera paulo ampliatis, annulis impressis (circa 20) plerisque oblongis, albo-squamulosis; pedibus validis, tibiis posticis intus fortiter denticulatis.

"Long. 6 lin.

"Hab. Luzon.

"The delicate rings on the elytra, from the fineness of the scales, have the appearance of being worm-eaten."

tubercles on underside of tibiae more strongly pronounced on hind tibiae, particularly in the male. Penis structure, Plate 2, fig. 38.

Male, length, 12 to 16 millimeters (without rostrum); width, 5 to 6.8. Female, length, 14 to 16 millimeters (without rostrum); width, 7 to 7.5.

LUZON, Benguet Subprovince, Baguio, Trinidad (McGregor; Schultze; Taylor).

This species is very common around Baguio at 1,600 meters altitude; I examined hundreds of specimens which show very great variation in the peculiar markings. At higher altitudes this species seems to be replaced by a rather characteristic form which I designate as:

Macrocyrtus (*Exmacrocyrtus*) *erosus* var. *impressimaculatus* var. nov.

Elytra with the puncture rows almost obliterated, the markings reduced, forming shorter or longer oblong or roundish impressed scale spots. The latter very much reduced in the male, in some instances almost absent.

LUZON, Benguet Subprovince, Mount Santo Tomas, 2,200 meters (Schultze); Mount Data, 2,300 meters (Ramos).

Macrocyrtus (*Exmacrocyrtus*) *pseudopolitus* Heller.

Macrocyrtus pseudopolitus HELLER, Philip. Journ. Sci. 19 (1921) 544.

Glossy black, nearly related to *M. erosus* Pascoe; elytra before apex with indistinct rudimentary greenish scale markings. Rostrum, dorsally irregularly punctured, with a shallow triangular depression and a medial groove reaching to the front. Prothorax longer than broad, sides very slightly rounded, subparallel, with a strongly pronounced anterior groove and a posterior submarginal groove, faintly and scatteredly punctured. Elytra short-ovate, finely and irregularly striate-punctate, sub-suturally at the beginning of the abrupt posterior slope a rather prominent protuberance; apical part of elytra projecting and with a small triangular excision at the sutural termination.

Female, length, 15 millimeters (without rostrum); width, 6.5.

LUZON, Benguet Subprovince, mountain trail, near Mount Data (Schultze).

This species (female) in general form is most closely related to *M. erosus* Pascoe, particularly to the var. *impressimaculatus* var. nov. The only specimen before me, a female, was compared by me with the type, a female, in the Dresden Museum. It seems probable that this species is only a local form of *M.*

(*E.*) *erosus* Pascoe, but the question of its identity can be decided only after more material of both sexes has been examined.

Macrocyrtus (*Exmacrocyrtus*) *negrito* Heller. Plate 1, fig. 11, ♂.

Macrocyrtus negrito HELLER, Philip. Journ. Sci. § D 7 (1912) 333.

Black, moderately glossy, elytra with scattered bluish or greenish scales, which in some instances form irregular spots. Rostrum longer than broad, scatteredly punctured, with a medial groove, which usually extends to the front. Prothorax slightly broader than long, the lateral margins gently rounded, very finely and scatteredly punctured, with an indistinct anterior groove and a distinct posterior submarginal groove. Dorsolaterally mostly an irregular oblong scale spot and at the lateral margins a roundish patch. Elytra oblong-ovate, in the male somewhat depressed dorsally, in the female more strongly convex and toward apex more abruptly convergent, finely striate-punctate and with irregular, ill-defined squamigerous marbled patches at base, in the middle at apical third, and an interrupted marginal stripe. Mesosternum and metasternum with a scale patch laterally. Hind femora in the male with a rather prominent obtuse tooth⁴ near base and four tubercles on hind tibiae. In the female the hind tibiae with about six very small tubercles beset with a short bristle.

Male, length, 16 millimeters (without rostrum); width, 7.8. Female, length, 17 millimeters (without rostrum); width, 8.

LUZON, Benguet Subprovince, Mount Pulog (*Curran*; type⁵ specimen No. 9909 Bureau of Science collection): Kalinga Subprovince, Balbalan (*Taylor*); Bangad (*Schultze*); Davangan (*Herre*): Nueva Vizcaya Province, Santa Fe Road, near Balete rest house, about 900 meters altitude, a male and a female in copula, May 14, 1924 (*Schultze*).

This species is very variable in sculpture and scale markings and seems to have an exceptional tendency to localism. The typical forms are found near Mount Pulog. Specimens from Davangan are very glossy; in the males the scale markings form rather distinct spots; the females are uniform black. Spec-

⁴ This secondary sexual character of the male is also found in the following species of the genus, although less strongly pronounced or only faintly indicated: *M. subcostatus* Heller, *M. ilocanus* Schultze, and *M. nigrans* Pascoe.

⁵ The locality Baguio, as given by Heller, is erroneous.

imens from Balbalan are black in both sexes, some are very glossy, and others are very finely coriaceous.

Macrocyrtus (*Exmacrocyrtus*) *ilocanus* Schultze. Plate 1, fig. 7, ♂.

Macrocyrtus ilocanus SCHULTZE, Philip. Journ. Sci. § D 13 (1918)
372, pl. 1, fig. 10, ♀.

Glossy black, prothorax and elytra with pale greenish white scale spots. Rostrum slightly divergent toward apex. Apically finely and densely punctured, more coarsely and irregularly so toward front. A shallow triangular depression in the middle of rostrum and a well-pronounced longitudinal medial groove, the latter reaching to front. Prothorax as long as broad at base. Dorsolaterally near posterior margin an oblong spot; a fine irregular and interrupted scale line along anterior margin and a large spot at each lateral margin. Elytra finely and regularly punctate-striate. Each elytron with eight irregular pale greenish white scale spots, the spotted areas slightly depressed. Two spots at base, one, the larger, discally, the other at lateral margin; two spots at the middle, the outer one reaching almost to lateral margin; three ill-defined spots forming a cross row in apical third and one spot near apex. Between the last-mentioned spots a number of scattered scales along margin. Legs sparsely punctured and finely setose. Underside of tibiae with a few tubercles. Penis structure, Plate 2, fig. 37.

Male, length, 16.5 millimeters (without rostrum); width, 7.5. Female, length, 16 millimeters (without rostrum); width, 8.

LUZON, Ilocos Norte Province, Mount Palimlim (*Schultze*).

Macrocyrtus (*Exmacrocyrtus*) *hieroglyphicus* Schultze.

Eupachyrrhynchus hieroglyphicus SCHULTZE, Philip. Journ. Sci. § D
12 (1917) 254, pl. 1, fig. 4, ♀.

Black, moderately glossy, prothorax and elytra with pale greenish or bluish white scale markings. Rostrum comparatively broad, strongly and confusedly punctured toward apex. A prominent squarish depression in basal half, the lateral edges of which are swollen, the depression with a fine longitudinal medial groove extending to front. Prothorax as long as broad, at base with a dorsolateral triangular spot, at middle a transverse dorsolateral spot more or less confluent with the former, and the lateral margins with a large scale spot. Elytra irregularly and indistinctly punctate-striate. Each elytron with four longitudinal more or less wavy stripes. The dorsal pair at base interrupted, forming two spots, afterward combined,

separated in the middle, forming an oblong loop, posterior of which the stripes approach each other, then separate again, forming a second loop at posterior slope. Another dorsolateral wavy stripe and a marginal stripe extend from base to apex; these two stripes run together at base, and all four stripes are confluent at apex. The striped areas very distinctly depressed. Suture and costal margin near apex with a few fine hairs. Apical sutural ends of elytra acutely divergent in the female. Legs sparsely and indistinctly punctured, finely setose, more strongly so on underside of tibiae.

Female, length, 16.5 millimeters (without rostrum); width, 7.75. Male unknown.

LUZON, Benguet Subprovince, Baguio and Irisan River (Schultze).

Macrocyrtus (*Exmacrocyrtus*) *trivittatus* Schultze. Plate 1, fig. 8, ♀; Plate 2, fig. 10, ♂ (lateral view).

Macrocyrtus trivittatus SCHULTZE, Deutsche Ent. Zeitschr. (1922) 42, pl. 1, fig. 4, ♂.

Dull black, head and prothorax with pale green scale markings, elytra with longitudinal stripes. Rostrum irregularly punctured, basal half with a large shallow and roundish depression and a fine longitudinal medial groove reaching to front. A bifid scale spot at base of rostrum and front. Prothorax as long as broad, at base dorsolaterally with a triangular scale spot, which is confluent in the female with a lateral spot in the middle. Lateral margins with a large irregular spot. Elytra oblong-ovate, finely coriaceous, indistinctly punctate-striate, in the male rounded at apex, in the female the apex forming a short beak-shaped projection, the apical ends slightly divergent, forming a small triangular excision. Each elytron with three stripes, these smaller in the male, but broader in the female; one of these stripes extends dorsolaterally from base to apex where it becomes confluent with a lateral-marginal stripe. Another stripe between sixth and seventh interstices extending from near base to near apex, where it also becomes confluent with the marginal stripe. Mesosternum, metasternum, and first abdominal sternite laterally with a scale spot. Underside of tibiae setose, more strongly so in the male. Penis structure, Plate 2, fig. 40.

Male, length, 15.5 millimeters (without rostrum); width, 6.5. Female, length, 16 millimeters (without rostrum); width, 7.

LUZON, Benguet Subprovince, Mount Pulog (Schultze): Nueva Vizcaya Province, Imugan (Boettcher).

This species has a remarkable likeness to *Pachyrrhynchus inclytus* Pascoe (= *P. modestior* Behrens).

Macrocyrtus (*Exmacrocyrtus*) *multipunctatus* Schultze. Plate 1, fig. 1, ♂; Plate 2, fig. 21, ♂ (lateral view).

Macrocyrtus multipunctatus SCHULTZE, Deutsche Ent. Zeitschr. (1922) 41.

Glossy black; head, prothorax, and elytra with light green scale markings. Rostrum twice as long as broad, the sides nearly parallel, dorsally irregularly scatteredly punctured, in the basal half with a shallow triangular depression and a strongly pronounced longitudinal medial groove extending to front. Latter finely and sparsely punctured with a bifid roundish scale spot. Sides of rostrum at base before eye with a distinct triangular depression, a small scale spot below eye. Prothorax slightly longer than broad, an irregular narrow scale band along anterior margin confluent with a large scale spot at each lateral margin, at base dorsolaterally an irregular oblong triangular scale spot. Elytra oblong-ovate, uniformly rounded at apex, finely and indistinctly punctate-striate, with a large number of scattered small roundish or oblong light green scale spots, forming irregular and indistinct transverse groups near base, in the middle, and at apical third. Mesosternum, metasternum, and first abdominal sternite with a scale patch laterally. Underside of tibiae with four obtuse or blunt teeth, more pronounced on posterior tibiae and sparsely setose. Penis structure, Plate 2, fig. 39.

Male, length, 14 millimeters (without rostrum); width, 6.5. Female unknown.

LUZON, Nueva Vizcaya Province, Imugan (*Boettcher*).

Macrocyrtus (*Exmacrocyrtus*) *kalinganus* Schultze. Plate 1, fig. 10, ♂; Plate 2, fig. 9, ♀ (lateral view).

Macrocyrtus kalinganus SCHULTZE, Deutsche Ent. Zeitschr. (1922) 42, pl. 1, fig. 3, ♀.

Glossy piceous (pitch brown) with a violet sheen; head, prothorax, and elytra with brilliant metallic scale spots. Rostrum scatteredly punctured with a very large and shallow depression reaching to front, almost entirely beset with a scale spot, and with a sharply defined longitudinal medial groove. Prothorax as long as broad, finely and scatteredly punctured, at base dorsolaterally a small triangular scale spot and another larger spot dorsolaterally before the middle. Lateral margins with a large oblong scale patch. Elytra irregularly and indis-

tinctly punctate-striate. Each elytron with eight scale spots and a small bifid sutural spot near apex. Five large, oval or roundish spots, two of which are at base, two in the middle, and one at apical third dorsolaterally. An elongate marginal spot extends backward from the middle, a small roundish spot is located between the latter and a triangular apical spot. Color of the scales of the spots is, in the marginal area of each spot, brilliant reddish golden, but in the central area metallic greenish or bluish. Elytra of male at apex evenly rounded, of female forming a short beaklike projection, the apical terminations slightly divergent, forming a small triangular excision. Mesosternum, metasternum, and first abdominal sternite with a scale spot laterally. Femora with a scale spot near apex. Under-side of tibiae setose, the hind tibiae more strongly so.

Male, length, 15.2 millimeters (without rostrum); width, 6.

Female, length, 16.5 millimeters (without rostrum); width, 7.5.

LUZON, Kalinga Subprovince, Balbalan (Taylor).

This species has the most remarkable likeness to *Pachyrrhynchus taylori* Schultze.

Genus EUMACROCIRTUS Schultze

Eumacrocyrtus SCHULTZE, Philip. Journ. Sci. 23 (1923) 599.

Related to *Macrocyrtus* Heller. Rostrum slightly longer than broad. Scape of antenna reaching beyond posterior margin of eye. Prothorax with distinct and sharply defined anterior and posterior submarginal groove, and a dimplelike depression dorsolaterally. Elytra dorsally slightly flattened, the greatest width in the middle, lateral margins from the middle rather abruptly and strongly convergent toward apex; apical fourth of elytra extending beyond abdomen, forming a mammilla-shaped projection in both sexes. First and second abdominal sternites in both sexes connate, the following three well segmented.

Type species, *Eumacrocyrtus canlaonensis* Schultze, from Negros, Philippine Islands.

Eumacrocyrtus canlaonensis Schultze. Plate 1, fig. 9, ♀; Plate 2, fig. 19, ♂, fig. 20, ♀ (lateral view).

Eumacrocyrtus canlaonensis SCHULTZE, Philip. Journ. Sci. 23 (1923) 599.

Dark brown, almost black, with inconspicuous pale bluish white scale markings. Rostrum dorsally scatteredly punctured, with an indistinct longitudinal groovelike depression extending to front, where it forms a well-pronounced groove; at base an

indistinct transverse depression. Prothorax as long as broad, glossy, finely and scatteredly punctured, a minute hair arising from each puncture, the punctures nearly obsolete in the male. A dimplelike depression dorsolaterally, nearer the middle than the base. At lateral margins an irregular patch of fine bluish white scales. Elytra finely, scatteredly punctured and sparsely granulate in the male, in the female the punctures much coarser and more irregular. Elytra dorsally in both sexes with very fine and evenly scattered scales. The latter toward and at basal and lateral margins gradually increase in size and density and are most strongly pronounced as an irregular broad stripe along basal and lateral margins. The apical mammillary projection slightly longer in the female, in both sexes beset with rather long scattered setæ arising from the punctures, particularly along the connate suture. Mesosternum slightly, metasternum and first and second abdominal sternites in the middle with a large and prominent patch of dense furlike ochraceous pubescence in both sexes. Legs reddish brown, femora irregularly punctured, sparsely setose. Tibiæ on underside with a number of small tubercles, moderately setose. Penis structure, Plate 2, fig. 41.

Male, length, 14.5 to 16 millimeters (without rostrum); width, 5.8 to 6.6. Female, length, 14 to 15.5 millimeters (without rostrum); width, 6 to 6.8.

NEGROS, Occidental Negros, Canlaon Volcano (*Taylor; Banks; Curran*).

Twenty specimens of this very characteristic species that I have examined show considerable variation in the punctures and sculpture of the elytra. The hind femora are slightly longer in the male than in the female.

Genus *APOCYRTUS* Erichson

Apocyrtus ERICHSON, Nov. Act. Ac. Leop. Carol. 16 (1834) Suppl. 1, 252; SCHOENHERR, Gen. Cure. 5 (1839) 824.

Rostrum dorsally slightly convex, separated at base from front by a deep and straight transverse groove. Eyes rather strongly bulging. Antenna reaching beyond hind margin of eye. Prothorax subglobular, anterior margin ventrally emarginate, at posterior margin strongly constricted. Scutellum absent. Elytra subglobularly inflated. First and second abdominal sternites in both sexes connate, the last three well segmented in the male; in the female, the third and fourth sternites suberect, more or less lamelliform, the fifth rather strongly

depressed. Hind femora in the male reaching well beyond apex of elytra, in the female only in line with the latter.

Type species, *Apocyrtus inflatus* Erichson, from Luzon, Philippine Islands.

Apocyrtus inflatus Erichson. Plate 2, fig. 5, ♂, fig. 6, ♀ (lateral view).

Apocyrtus inflatus ERICHSON, Nov. Act. Ac. Leop. Carol. 16 (1834) Suppl. 1, 254, pl. 38, fig. 8; BOHEMAN, Schoenherr. Gen. Curc. 5 (1839) 824; WATERHOUSE, Ann. & Mag. Nat. Hist. 11 (1843) 249; HELLER, Philip. Journ. Sci. § D 7 (1912) 301, pl. 1, figs. 1, 1a.

Head, prothorax, underside, and legs black, elytra dark reddish brown to black. Rostrum irregularly punctured, basal half with a strongly pronounced medial groove extending to front, the basal transverse groove deep. Front scatteredly punctured, and with a few scales. Prothorax subglobular, beset with large, roundish, polished, glossy tubercles, except a small anterior submarginal and posterior submarginal stripe which is smooth. Dorsally an indistinct medial groove, beset with an interrupted line of pale green scales, at each lateral margin an irregular oblong patch of pale green scales and in some specimens a few scattered scales dorsolaterally near anterior margin. Elytra strongly inflated, subspherical, apical sutural decline abrupt, in the male rounded at apex, in the female with a small triangular excision; rather coarsely sculptured, rugose, and subtuberculate in irregular rows. A small irregular scale spot near base laterally and another more triangular spot laterally near apex, along margin some irregularly scattered scales. Mesosternum and metasternum with a patch of scales laterally. In the female the third abdominal sternite with a suberect bilobed lamelliform appendage, the fourth with a flattened, triangular appendage in the middle, the fifth with a rather strong depression. Penis structure, Plate 2, fig. 27.

Male, length, 9 to 11 millimeters (without rostrum); width, 4.6 to 6. Female, length, 10 to 11.5 millimeters (without rostrum); width, 5.5 to 6.2.

LUZON, Laguna Province, Paete (*McGregor*; *Schultze*): Rizal Province, Montalban. POLILLO (*Schultze*).

In two specimens from Polillo, females, the sculpture appears slightly coarser; but, otherwise, I am unable to detect any appreciable differences in a comparison with a large series of this species from Luzon.

Apocyrtus mcgregori sp. nov. Plate 2, fig. 30, ♂, fig. 31, ♀.

Black with pale yellowish scale markings. Smaller, slenderer, and not so strongly inflated as *A. inflatus* Erichson. Rostrum densely and confusedly punctured, with a medial groove-like depression in basal half, the transverse basal groove strongly defined. Front slightly depressed, with a medial groove, and entirely covered by a large scale spot. Sides of head with a few scales below eye. Prothorax subglobular, as long as broad, strongly roundish granulate with an indistinct medial groove and a broad, ill-defined medial scale stripe. Dorsolaterally another ill-defined stripe more or less confluent with a large scale patch at lateral margins reaching from anterior to posterior margin. Elytra similar in form to *A. inflatus*, but not so strongly inflated, irregularly striate-punctate, the punctures dorsally very large, toward the sides confused, the interstices more or less subtuberculate. Female at the beginning of apical decline with a sutural knoblike swelling, the latter as well as the sutural region to apex beset with fine scattered setæ. Each elytron with five broad and irregular, more or less interrupted longitudinal scale stripes and an irregular abbreviated sutural stripe. The stripes are confluent at base in the male; they are broader than the bare interspaces and have a tendency to form oblong spots, particularly in the female. Underside, mesosternum, metasternum, and first abdominal sternite laterally with a scale patch. Third to fifth abdominal sternites in female lamelliform, suberect, with the hind margins evenly rounded.

Male, length, 9.3 millimeters (without rostrum); width, 3.8. Female, length, 10 millimeters (without rostrum); width, 4.7.

LUZON, Bataan Province, Lamao (*Schultze*).

This species is easily recognized on account of the peculiar stripe markings and bears a strong superficial resemblance to *Pseudapocyrtus multimaculatus* *Schultze*. I take pleasure in naming this species for my friend Mr. R. C. McGregor, ornithologist of the Philippine Bureau of Science.

Genus *PROAPOCYRTUS* Schultze

Proapocyrtus SCHULTZE, Philip. Journ. Sci. § D 13 (1918) 371.

Rostrum with a prominent medial groove, extending to vertex, and a strongly pronounced transverse groove before eyes. Antenna with first and second funicular joints of equal length, third to seventh also equal in length, together one-fifth longer than first and second. Prothorax subcylindrical, dorsally some-

what flattened, with an anterior and a posterior submarginal groove. Elytra dorsally flattened, laterally strongly and abruptly declined in an acute angle, apically produced, on the posterior decline with prominent subsutural ridges, and apical ends of elytra divergent. Hind femora reaching to about the third fourth of length of elytra posteriorly.

Type species, *Proapocyrtus insularis* Schultze, from Panay, Philippine Islands.

This genus is most nearly related to *Apocyrtus* Erichson, but it is easily recognizable by the oblong-oval and dorsally flattened form of the elytra, as compared with the more spherical and inflated elytra of that genus.

Proapocyrtus insularis Schultze.

Proapocyrtus insularis SCHULTZE, Philip. Journ. Sci. § D 13 (1918) 371, pl. 1, fig. 1.

Black, with pale green scale spots. Rostrum very irregularly and coarsely, front more finely, sparsely, and scatteredly punctured. The medial groove broad, on front and vertex fine and narrow. Prothorax strongly coriaceous, with an irregular medial groove. A small spot at middle laterad and another, larger spot at lateral margin. Elytra very coarsely and irregularly punctate-striate, the interstices forming raised ridges. The lateral decline of elytra with deep elongated depressions. Each elytron with eight scale spots, and one bifid spot on suture at posterior decline. The eight spots are located as follows: Two near base, the one at lateral margin the larger; four in the middle area, two of which are at disk, one at the lateral decline, the other at lateral margin; one at apical third; and one in apical triangle. Legs finely and scatteredly punctured, the tibiae finely and sparsely setose.

Length, 15 millimeters; width, 6.5.

PANAY, Capiz Province, mountains near Jamindan: Antique Province, Culasi (*McGregor*).

The spots are somewhat variable in color; in one of the specimens from Culasi they are blue.

Genus *PSEUDAPOCYRTUS* Heller

Pseudapocyrtus HELLER, Philip. Journ. Sci. § D 7 (1912) 326.

Rostrum slightly longer than broad, convex, confluent with front, dorsally without any impression. Upper margin of

scrobe distinctly carinate. Scape of antenna reaching well beyond hind margin of eye. Eyes moderately convex. Prothorax truncate at base. Elytra convex and more or less strongly inflated. First and second abdominal sternites in both sexes connate, in the female the third sternite not with a suberect lamelliform appendage.

Type species, *Pseudapocyrtus imitator* Heller, from Luzon, Philippine Islands.

This genus is very nearly related to *Apocyrtus* Erichson, but the latter is readily distinguished by the strongly pronounced and straight transverse basal groove of rostrum, which in *Pseudapocyrtus* is almost obsolete and more or less V-shaped. Certain species included in the genus *Pseudapocyrtus* have rather a heterogeneous aspect from the typical species *P. imitator* Heller, on account of the difference in the form of the prothorax, which in the latter is subcylindrical and in others, such as *P. formicarius* Heller, subglobular. In view of the fact that the other characters agree fairly well, it seems better to retain them in this genus for the present.

Key to species of Pseudapocyrtus Heller.

*a*¹. Prothorax subcylindrical, longer than broad.

*b*¹. Elytra dorsally without any distinct longitudinal ridges.

*b*². Elytra dorsally with distinct ridges and pale blue scale spots.

P. imitator Heller.

*c*¹. Elytra irregularly striate-punctate, the punctures not confluent, and with creamy white scale spots..... *P. apicatus* Schultze.

*c*². Elytra coarsely and confusedly striate-punctate, punctures larger than the irregularly confluent interstices..... *P. productus* Heller.

*a*². Prothorax subglobular.

*d*¹. General color black, elytra with ring markings or well-defined spots.

*e*¹. Elytra with pale flesh colored scale ring spots.

P. schadenbergi Heller.

*e*². Elytra with numerous but well-defined pale green scale spots.

P. multimaculatus Schultze.

*d*². General color not black.

*f*¹. Prothorax red, elytra black.

*f*². Prothorax black, elytra reddish brown, the latter before apex at lateral margins with a deep curved excision.

P. exsectus Heller.

*g*¹. Prothorax dorsally red, relatively larger than in the following species; apical prolongation of elytra less strongly pronounced.

P. formicarius Heller.

*g*². Prothorax relatively smaller than in *P. formicarius*; apical prolongation of elytra longer and more strongly pronounced than in the latter..... *P. catanduanensis* Schultze.

Pseudapocyrtus imitator Heller. Plate 2, fig. 17, ♂, fig. 18, ♀ (lateral view).

Pseudapocyrtus imitator HELLER, Philip. Journ. Sci. § D 7 (1912) 329, pl. 1, figs. 2, 2a; pl. 2, fig. 2.

Black, elytra dark reddish brown with pale bluish scale markings. Rostrum scatteredly and finely punctured, separated by a fine V-shaped groove from front, the latter with an abbreviated medial groove and sparsely punctured. Antenna reddish brown. Prothorax subcylindrical, longer than broad, the greatest width in the middle, dorsally flattish granulate with an indistinct medial groove, beset with a narrow and irregular stripe of scales, lateral margins with a large blue scale patch. Elytra subglobular, the apical part laterally constricted, forming an apically rounded prolongation, coarsely striate-punctate, the interstices forming distinct ridges dorsally, at sides the sculpture more confused. Each elytron with a scale spot in the middle at base, another near the latter and the margin, in the middle a transverse row of about three spots, an oblong marginal spot slightly behind the middle, two dorsolateral spots at apical third and another spot near apex, some specimens with a sutural spot at apical decline. Underside glossy black, mesosternum and metasternum with a scale spot laterally. Legs red, except apical part of femora, which is black.

Male, length, 9 millimeters (without rostrum); width, 4.5. Female, length, 9 to 10 millimeters (without rostrum); width, 4.8 to 5.

LUZON, Benguet Subprovince, Irisan (McGregor); Baguio, Mount Santo Tomas (Schultze).

Pseudapocyrtus apicatus Schultze. Plate 2, fig. 26, ♀.

Pseudapocyrtus apicatus SCHULTZE, Philip. Journ. Sci. 21 (1922) 581, pl. 1, fig. 7, ♀.

Head, prothorax, and legs black, elytra castaneous brown with cream colored scale spots. Related to *P. imitator* Heller. Rostrum dorsally slightly convex, densely punctured, at base separated from front by a curved transverse groove. Front scatteredly punctured, with a medial groove and a scale spot. Prothorax subcylindrical, longer than broad, coarsely and transversely rugose with an indistinct longitudinal medial groove. Dorsolaterally a not very densely scaled stripe reaching from anterior to posterior margin, and another broader

stripe at lateral margins. Elytra moderately glossy, irregularly striate-punctate. Each elytron with seven large scale spots, one at base, five in the middle part, two of which are located at lateral margin, and a large triangular spot at apical projection. The projection at lateral margin apically with a small curved excision, the sutural ends curved downward, resembling a beak in shape. Mesosternum and metasternum laterally with a scale spot. Last abdominal sternite with a curved excision. Hind femora not reaching beyond elytra.

Female, length, 10.5 millimeters (without rostrum); width, 4.5.

LUZON, Bontoc Subprovince (*Schultze*).

Pseudapocyrtus productus Heller.

Pseudapocyrtus productus HELLER, Philip. Journ. Sci. § D 7 (1912) 330.

Black; elytra reddish yellowish brown to castaneous, sides blackish, with a greenish scale spot at base and two at lateral margins. Rostrum finely punctured, front with an anteriorly forked medial groove. Prothorax subcylindrical, slightly longer than broad, polished off granulate, lateral margins with some greenish scales. Elytra coarsely and confusedly striate-punctate, the punctures larger than the irregularly confluent interstices. Sides of elytra from base to middle nearly straight but divergent, then roundish inflated, the apical part forming a beak-shaped projection, each elytron at apex with a small knob, the lateral margins at apex with a short and small emargination in the female, in the male with a small sutural knob behind second third. At base a small transverse scale spot, another oblong spot at lateral margin anteriorly, and a stripelike greenish scale spot posteriorly. Mesosternum and metasternum with a scale patch laterally. Legs, with the exception of the black apical parts of femora, reddish. Hind femora not reaching beyond apex of elytra (♀ !, ♂ ?).

Length, 12 to 13 millimeters; width, 6 to 6.5.

Philippine Islands, exact locality unknown (*Semper*).

This species I know only from the original description. The statement in the last sentence concerning the hind femora, as given by Heller, seems strange to me, since in the species of this genus known to me the hind femora of the males do extend beyond apex of elytra.

Pseudapocyrtus schadenbergi Heller. Plate 2, fig. 22, ♀ (lateral view).

Pseudapocyrtus schadenbergi HELLER, Philip. Journ. Sci. § D 7 (1912) 327, pl. 2, fig. 3.

Black, moderately glossy, in general body form similar to *A. inflatus* Erichson; scale markings on prothorax pale green, scale-ring spots on elytra pale flesh colored. Rostrum scatteredly punctured with an indistinct medial groove, which forms a punctiform depression at base and becomes obsolete at front. Prothorax subglobular, with an ill-defined anterior and a well-defined posterior submarginal groove, only the marginal areas smooth, otherwise coarsely granulate but polished off. Dorsolaterally an irregular scale patch, and another at lateral margin. Elytra short-ovate, apical fourth laterally depressed, forming a nasutiform projection, very coarsely striate-punctate, the punctures somewhat irregular toward lateral margins. Each elytron with about thirteen roundish scale spots, the center part of most of which is bare. Four spots are located at basal fourth, three spots form a transverse row at about the middle, one elongate marginal spot behind the middle, and five spots and a large bifid sutural spot are located at apical third. Mesosternum, metasternum, and first abdominal sternite laterally with a scale spot. Abdominal sternites rugose and, except the first and the last, connate. Hind femora not reaching apex of elytra in the female, but extending well beyond in the male.

Male, length, 10 millimeters (without rostrum); width, 5. Female, length, 12 millimeters (without rostrum); width, 5.7.

LUZON (*Schadenberg*); Ilocos Norte Province, Mount Palimlim (*Schultze*).

Heller's type specimen is undoubtedly a male, since he mentions the hind femora extending beyond the apex of the elytra.

Pseudapocyrtus multimaculatus Schultze.

Pseudapocyrtus multimaculatus SCHULTZE, Philip. Journ. Sci. § D 13 (1918) 372, pl. 1, fig. 2.

Glossy black, with pale green spots. Rostrum densely and irregularly punctured. A prominent medial groove from base of rostrum reaching to vertex. A large scale spot on front. Prothorax as long as broad, strongly coriaceous. A prominent medial groove, beset with scales, laterad of which a broad irregular scale stripe, another at lateral margin. Elytra shiny, irregularly punctate-striate, the punctures very coarse. The interstices forming slightly elevated ridges or callosities. Spot-

ted areas depressed. Basal area with a series of six irregular pale green scale spots. At the middle, forming a cross row, a series of four spots, and in apical third a series of five, slightly larger spots. A lateral-marginal stripe extending from base to second third only. In posterior half a subsutural series of spots, forming an interrupted stripe which terminates near apex. Underside with a spot laterally at mesosternum and metasternum, and the visible parts of abdominal sternites. Legs finely and sparsely punctured, rugose, and finely setose.

Length, 12 millimeters; width, 5.5.

LUZON, Ilocos Norte Province, Mount Palimlim (*Duyag*).

Pseudapocyrtus exsectus Heller.

Pseudapocyrtus exsectus HELLER, Philip. Journ. Sci. § D 7 (1912) 328, pl. 1, fig. 25 (elytra, lateral view).

Black; elytra, middle part of femora, tibiae and tarsi reddish brown. More similar to *Apocyrtus inflatus* than to *Pseudapocyrtus imitator* Heller, slightly larger than both. Rostrum slightly conically obtuse, moderately densely and finely punctured. Antennae as in *P. imitator*, front with an oblong greenish scale spot. Prothorax subglobular, slightly broader than long, the greatest width somewhat nearer the base, netlike strongly polished off granulate, with a few impressed punctures and a narrow medial stripe of greenish scales. Elytra subglobular, coarsely irregularly striate-punctate, the punctures more or less confused and confluent. Lateral margins near apex with an elongate curved excision, above which is located an elongate greenish scale spot. Lateral margins of prothorax, mesosternum, and metasternum laterally with some scattered greenish scales.

Female, length, 11.5 millimeters (without rostrum); width, 6.5.

Philippine Islands, exact locality unknown (Dresden Museum, ex coll. Kirsch).

This species I know only from the description.

Pseudapocyrtus formicarius Heller. Plate 2, fig. 13, ♂, fig. 14, ♀ (lateral view).

Pseudapocyrtus formicarius HELLER, Philip. Journ. Sci. § D 7 (1912) 327, pl. 2, fig. 1; SCHULTZE, Philip. Journ. Sci. 21 (1922) 583.

Black; prothorax dorsally, antennal scape, and femora, except basal and apical parts, red. Rostrum moderately densely and finely punctured. Front between eyes with a punctiform

impression. First funicular joint slightly longer than the elongate second, third elliptical, the following globular, gaining in size toward club, the latter longer than the five preceding funicular joints together. Prothorax subspherical, very slightly longer than broad, dorsally red and polished off granulate with a fine medial groove and an anterior and a posterior submarginal groove. The narrow anterior marginal area also black and distinctly swollen. The red color dorsally changes to black at lateral margins, where the granulation also becomes obsolete and where a few scattered pale greenish scales are located. Elytra subglobular, strongly inflated, laterally the apical fifth depressed, forming in the male a short prolongation rounded at apex, in the female the prolongation more pronounced, more acute at apex, the apical sutural termination with a curved excision and another curved excision laterally, so that each elytron ends in an acute toothlike point. Elytra very regularly striate-punctate, the punctures very coarse, at sides some distantly scattered pale greenish or bluish scales. First and second abdominal sternites in the female connate, the apparently third sternite retracted but flat, at apex with an oblong excision. Hind femora in the female reaching to apex of elytra, in the male well beyond. The penis structure, Plate 2, fig. 28, shows clearly the approximate relation of this species to *A. inflatus* Erichson, and in a still stronger degree to *P. catanduanensis* Schultze.

Male, length, 9 millimeters (without rostrum); width, 4.5. Female, length, 10.8 to 11.6 millimeters (without rostrum); width, 5.5 to 6.

POLILLO (*McGregor; my collector*).

The type locality "Luzon orientalis;" (Dr. C. Semper and J. Whitehead) seems doubtful to me.

Pseudapocyrtus catanduanensis Schultze. Plate 2, fig. 23, ♂, fig. 24, ♀ (lateral view).

Pseudapocyrtus catanduanensis SCHULTZE, Philip. Journ. Sci. 21 (1922) 582, pl. 2, fig. 7, ♀ (pl. 7, fig. 12, penis structure).

Black; scape of antenna, prothorax dorsally, and legs red, except apical part of femora and tibiae and the tarsi, which are also black. Nearly related to *P. formicarius* Heller. Rostrum finely and scatteredly punctured, in basal half with a sharply defined medial groove terminating at the beginning of the front in a punctiform impression. Prothorax subspherical, as long as broad, polished off granulate with a well-pronounced medial

groove and an anterior and a posterior submarginal groove. The submarginal areas also black and swollen. Prothorax relatively smaller than in *P. formicarius*. Elytra in the male one and one-fifth times as long as broad, strongly inflated, subglobular or short-ovate, near apex laterally slightly depressed, at apex rounded; in the female one and one-half times as long as broad, apical third laterally strongly depressed, forming a nasutiform prolongation. Apical termination of elytra as in *P. formicarius*, but more pronounced. Sculpture of elytra also as in the latter, but coarser, also some sparsely scattered scales at sides. Hind femora in the female not reaching to apex of elytra, in the male well beyond. Penis structure, Plate 2, fig. 29.

Male, length, 9.5 to 10 millimeters (without rostrum); width, 4.5 to 4.7. Female, length, 11 to 12 millimeters (without rostrum); width, 5 to 5.7.

CATANDUANES, Virac (*Schultze*).

Genus *NOTHAPOCYRTUS* Heller

Nothapocyrtus HELLER, Philip. Journ. Sci. § D 7 (1912) 334.

Rostrum longer than broad, with a broad shallow longitudinal dorsal groove-like depression reaching to front. Eyes relatively large, moderately convex. Scape of antennæ reaching posteriorly slightly beyond anterior margin of prothorax. The latter subcylindrical, longer than broad. Elytra spindle-shaped, but truncate at base, basal margin not carinate. The last three abdominal sternites in both sexes not connate, anal sternite in female swollen in the middle and depressed laterally. Hind femora of female reaching to apex of elytra, but in male reaching well beyond.

Type species, *Nothapocyrtus translucidus* Heller, from Luzon, Philippine Islands.

Heller founded this genus on a supposedly female specimen of *N. translucidus* but, from his description, "Decken, und die diese deutlich überragenden Hinterschenkel," it seems certain this is a mistake, since it is only in the male that the femora extend distinctly beyond the apex of the elytra. Furthermore, he included in this genus, provisionally, two other rather heterogeneous species, *N. cylindricollis* and *N. erythromerus* Heller. These two species, as well as all other species described up to the present as belonging to the above genus, must be placed in a new genus.

Nothapocyrtus translucidus Heller. Plate 1, fig. 4, ♀; Plate 2, fig. 7, ♂, fig. 8, ♀ (lateral view).

Nothapocyrtus translucidus HELLER, Philip. Journ. Sci. § D 7 (1912) 335.

Black; elytra light reddish brown or castaneous brown except a basal and a lateral marginal stripe and the apical area, which are black. Rostrum scatteredly and rather coarsely punctured, longer than broad, a broad longitudinal depression, extending to front, laterally set off by indistinct ridges, the latter of which are slightly convergent toward base. Prothorax glossy, coarsely and scatteredly punctured, sides slightly convergent toward anterior margin, dorsolaterally an ill-defined abbreviated longitudinal stripe of blue scales, extending from base to about middle. Another irregular scale patch at lateral margin. Elytra striate-punctate, the punctures rather coarse, finely and sparsely setose near apex. Each elytron with a small blue scale spot near apex. Apical termination of elytra in the female in lateral view more strongly curved, beaklike. Underside glossy black. Mesosternum and metasternum laterally with a patch of blue scales. Legs sparsely and finely whitish setose. Penis structure, Plate 2, fig. 34.

Male, length, 6.8 millimeters (with rostrum); width, 2.5. Female, length, 7.2 millimeters (with rostrum); width, 2.8.

LUZON, Benguet Subprovince, Mount Santo Tomas (*Schultze*); Cabayan (*McGregor*).

Heller's type is undoubtedly a rather young specimen, not fully hardened, since in fresh specimens the color of the elytra is reddish yellowish brown; it becomes darker castaneous brown in fully developed specimens.

Genus *EXNOTHAPOCYRTUS* novum

Rostrum longer than broad, divergent toward apex, dorsally with a very broad but shallow depression and an indistinct medial groove, the dorsolateral margins swollen. Front with a punctiform impression, from which extends an almost obsolete groove obliquely to anterior margin of eyes. Prothorax subcylindrical, longer than broad. Elytra oblong-oval, truncate at base, in the female dorsally slightly flattened, and at apex with a triangular sutural excision. Elytra of the male at apex broadly rounded, the posterior slope more abrupt. Hind femora in the female extending up to, or slightly beyond, apex of elytra; in the male well beyond.

Type species, *Exnothapocyrtus cylindricollis* Heller, from Luzon.

The species of this genus were formerly placed in the genus *Nothapocyrtus* Heller; but, on account of the different general body shape and the much larger size, their status in that genus cannot be retained.

Key to species of Exnothapocyrtus g. nov.

- a¹. Elytra with pale green or white scale markings.
- b¹. Elytra without fine, scattered, white hair.
- b². Elytra with fine, scattered, white hair, at lateral margin two scale spots..... *E. erythromerus* Heller.
- c¹. Elytra with eighteen to twenty moderately sized pale greenish white scale spots..... *E. cylindricollis* Heller.
- c². Elytra with twelve large white scale spots.
 - E. alboplagiatus* Heller.
- a². Elytra with blue scale markings.
- d¹. Each elytron with four well-defined spots; two at base, one at lateral margin, one near apex..... *E. luzonicus* Schultze.
- d². Elytra with irregular transverse scale band at base and middle, two spots at margin, one spot near apex..... *E. basifasciatus* Heller.

Exnothapocyrtus cylindricollis Heller. Plate 2, fig. 15, ♂, fig. 16, ♀ (lateral view).

Nothapocyrtus cylindricollis HELLER, Philip. Journ. Sci. § D 7 (1912) 336, pl. 2, fig. 6, ♂.

Nothapocyrtus chloropunctatus HELLER, Deutsche Ent. Zeitschr. (1916) 282.

Dark castaneous brown to almost black, glossy, with pale greenish white or bluish white scale spots. Rostrum longer than broad, divergent toward apex, dorsally with a large oblong shallow depression and an indistinct medial groove. Apical half, as well as toward lateral margins, irregularly punctured and very finely setose. Prothorax slightly longer than broad, subcylindrical, near anterior margin very moderately convergent, finely and scatteredly punctured. Dorsolaterally in the middle, toward each side, a small scale spot mostly smaller than eye and at lateral margins a large oblong scale patch. Elytra oval, dorsally moderately flattened in the female, slenderer and dorsally more convex in the male, apical area black, with an indistinct transverse constriction in both sexes, with regular rows of fine punctures. Each elytron mostly with nine or ten scale spots placed as follows: Two spots at base, three spots form an oblique transverse row before the middle, three or four spots form an irregular transverse row at apical third, the lateral

marginal spot of which is the largest, and a more or less triangular spot near apex. Mesosternum and metasternum with a scale spot laterally. Last three abdominal sternites in both sexes not connate. Penis structure, Plate 2, fig. 32.

Male, length, 9.2 to 10.6 millimeters (with rostrum); width, 3.5 to 3.8. Female, length, 11.6 millimeters (with rostrum); width, 4.

LUZON, Benguet Subprovince, Baguio, Mount Mirador (Schultze).

Heller's description of *Nothapocyrtus cylindricollis* is based on a single male, and of *N. chloropunctatus* on a single female specimen.

This species is rather variable with reference to the scale markings. Among numerous specimens examined several were found in which the spots were almost absent, or only represented by faint traces, and the dorsolateral spots on the prothorax are sometimes elongated, forming an interrupted stripe.

Exnothapocyrtus alboplagiatus Heller.

Nothapocyrtus alboplagiatus HELLER, Deutsche Ent. Zeitschr. (1916) 281.

Black; head, prothorax, and elytra with chalk white scale markings. Rostrum distinctly longer than broad, toward apex slightly divergent, dorsally with a broad and shallow concave depression, scatteredly punctured. Front with an elongate scale spot. Scape of antenna reaching slightly beyond anterior margin of prothorax. The latter as long as broad at base, quite conical, dorsally very finely shagreened, discally with some irregularly scattered coarse punctures and with a broad scale stripe at each lateral margin. Elytra ovate, each elytron with nine puncture rows, of which the ninth row is at the apical fifth, groovelike depressed, with six large more or less oval scale spots. The first row with three spots between first and fourth puncture rows, the second row with one spot in the middle between fifth and eighth puncture rows, and the third row with two spots, one, placed somewhat anteriorly, between the seventh and ninth puncture rows, the other between the eighth and ninth puncture rows. Mesosternum, metasternum, and first abdominal sternite laterally with a scale spot. Hind femora reaching to apex of elytra.

Female (?), length, 8.5 millimeters; width, 3.6.

LUZON, Benguet Subprovince, Baguio.

This species, which I know only from Heller's description,

presumably refers to a female specimen and seems very closely related to *Exnothapocyrtus cylindricollis* Heller.

***Exnothapocyrtus erythromerus* Heller.**

Nothapocyrtus erythromerus HELLER, Philip. Journ. Sci. § D 7 (1912) 336.

Nothapocyrtus subpilosulus HELLER, Philip. Journ. Sci. 19 (1921) 546.

Castaneous brown to black; head, prothorax, elytra, and legs beset with fine, scattered, whitish hair. Closely related to *E. cylindricollis* Heller. Rostrum one and one-half times as long as broad, rather strongly divergent toward apex, with a well-pronounced shallow dorsal depression in basal half, scatteredly punctured. Front with an almost obsolete medial groove. Prothorax scatteredly punctured, with faint traces of a groove-like medial depression in basal half and a few pale bluish white scattered scales at each lateral margin. Elytra regularly striate-punctate, the punctures more or less obsolete toward lateral margin. At lateral margin before the middle a small pale greenish scale spot and behind the middle an oblong spot. Apical part of elytra and underside black, the latter also beset with scattered and fine whitish hair.

Male, length, 9.5 millimeters (without rostrum); width, 3.8. Female, length, 10 millimeters (without rostrum); width, 4.

LUZON, Benguet Subprovince, Baguio; Mount Santo Tomas (*Schultze*).

The scale markings in this species are variable, in some specimens almost absent. I have no doubt that the description of *Nothapocyrtus subpilosulus* Heller refers to a female of this species.

***Exnothapocyrtus luzonicus* Schultze.**

Nothapocyrtus luzonicus SCHULTZE, Philip. Journ. Sci. § D 12 (1917) 256, pl. 1, fig. 6, ♀.

Castaneous, very glossy. Rostrum dorsally with irregular and scattered punctures, a large shallow depression, and an indistinct longitudinal groove terminating between eyes. Prothorax finely and irregularly punctured, with a large light green or bluish scale spot at lateral margin. Elytra finely but distinctly striate-punctate. Each elytron with four lapis lazuli colored scale spots, two at base, one of which is near suture and the other at lateral margin, an oblong spot apically at lateral margin, and one spot at apical triangle. Besides the above-mentioned spots there are traces of another, in the female only, at lateral margin before the middle. Female with the suture

apically strongly swollen, at apex with a triangular excision, in the male the latter evenly rounded. Mesosternum and metasternum with a scale spot laterally. Legs finely and scatteredly punctured and finely setose.

Male, length, 11 millimeters (without rostrum); width, 4.5. Female, length, 12 millimeters (without rostrum); width, 5.

LUZON, Benguet Subprovince, Pauai (Haight's place) (*Schultze*).

Exnothapocyrtus basifasciatus Heller. Plate 1, fig. 5, ♂; Plate 2, fig. 25, ♂ (lateral view).

Nothapocyrtus basifasciatus HELLER, Philip. Journ. Sci. 19 (1921) 545.

Castaneous brown to almost black, glossy, prothorax and elytra with cobalt blue scale markings. Rostrum very similar to *E. luzonicus* *Schultze*. Prothorax finely and scatteredly punctured, the punctures somewhat obliterated. Dorsolaterally an indistinct scale spot, absent in some specimens; at lateral margins another large and irregular scale patch. Elytra elongate-elliptic, striate-punctate, the punctures finer toward apex and near the latter more or less pronouncedly punctate-striate. At base an irregular blue crossband, in the middle another irregular transverse band, which may be absent; before and behind the middle of margin a scale spot, and a roundish or triangular spot before apex. Mesosternum and metasternum laterally also with a blue scale patch. Hind femora in the male extending well beyond apex of elytra. Penis structure, Plate 2, fig. 33.

Male, length, 11 to 11.8 millimeters (without rostrum); width, 4.5 to 4.8.

LUZON, Nueva Vizcaya Province, Imugan (*Baker*); Santa Fe Road near Balete Pass (*Schultze*); Kalinga Subprovince, Davanggan (*Herre*).

This species was also described from a single specimen, a male (?). It seems very variable in the scale markings, since in one of the two specimens (males) before me, the dorsolateral spots on prothorax are absent as well as the band in the middle of elytra. Furthermore, the punctures on prothorax and elytra are somewhat variable, more or less strongly pronounced. This species is very closely related to *E. luzonicus* *Schultze*.

ILLUSTRATIONS

[Original drawings by W. Schultze.]

PLATE 1

- FIG. 1. *Macrocyrtus* (*Exmacrocyrtus*) *multipunctatus* Schultze, male, $\times 2$. Luzon, Nueva Vizcaya Province, Imugan.
 2. *Macrocyrtus* (*Macrocyrtus*) *subcostatus* Heller, male, $\times 2$. Luzon, Benguet Subprovince, Mount Santo Tomas.
 3. *Macrocyrtus* (*Macrocyrtus*) *nigrans* Pascoe, female, $\times 2$. Luzon, Benguet Subprovince, Baguio.
 4. *Nothapocyrtus translucidus* Heller, female, $\times 2.5$. Luzon, Benguet Subprovince, Mount Santo Tomas.
 5. *Exnothapocyrtus basifasciatus* Heller, male, $\times 2$. Luzon, Kalinga Subprovince, Davangan.
 6. *Macrocyrtus* (*Exmacrocyrtus*) *erosus* Pascoe, female, $\times 2$. Luzon, Benguet Subprovince, Baguio.
 7. *Macrocyrtus* (*Exmacrocyrtus*) *ilocanus* Schultze, male, $\times 2$. Luzon, Ilocos Norte Province, Mount Palimlim.
 8. *Macrocyrtus* (*Exmacrocyrtus*) *trivittatus* Schultze, female, $\times 2$. Luzon, Nueva Vizcaya, Imugan.
 9. *Eumacrocyrtus canlaonensis* Schultze, female, $\times 2$. Occidental Negros, Mount Canlaon.
 10. *Macrocyrtus* (*Exmacrocyrtus*) *kalinganus* Schultze, male, $\times 2$. Luzon, Kalinga Subprovince, Balbalan.
 11. *Macrocyrtus* (*Exmacrocyrtus*) *negrito* Heller, male, $\times 2$. Luzon, Benguet Subprovince, Mount Pulog.

PLATE 2

- FIG. 1. *Macrocyrtus* (*Exmacrocyrtus*) *erosus* Pascoe, male.
 2. *Macrocyrtus* (*Exmacrocyrtus*) *erosus* Pascoe, female.
 3. *Macrocyrtus* (*Macrocyrtus*) *nigrans* Pascoe, male.
 4. *Macrocyrtus* (*Macrocyrtus*) *nigrans* Pascoe, female.
 5. *Apocyrtus inflatus* Erichson, male.
 6. *Apocyrtus inflatus* Erichson, female.
 7. *Nothapocyrtus translucidus* Heller, male.
 8. *Nothapocyrtus translucidus* Heller, female.
 9. *Macrocyrtus* (*Exmacrocyrtus*) *kalinganus* Schultze, female.
 10. *Macrocyrtus* (*Exmacrocyrtus*) *trivittatus* Schultze, female.
 11. *Macrocyrtus* (*Macrocyrtus*) *castaneus* Pascoe, male.
 12. *Macrocyrtus* (*Macrocyrtus*) *castaneus* Pascoe, female.
 13. *Pseudapocyrtus formicarius* Heller, male.
 14. *Pseudapocyrtus formicarius* Heller, female.
 15. *Exnothapocyrtus cylindricollis* Heller, male.
 16. *Exnothapocyrtus cylindricollis* Heller, female.
 17. *Pseudapocyrtus imitator* Heller, male.

18. *Pseudapocyrtus imitator* Heller, female.
19. *Eumacrocyrtus canlaonensis* Schultze, male.
20. *Eumacrocyrtus canlaonensis* Schultze, female.
21. *Macrocyrtus* (*Exmacrocyrtus*) *multipunctatus* Schultze, male.
22. *Pseudapocyrtus schadenbergi* Heller, female.
23. *Pseudapocyrtus catanduanensis* Schultze, male.
24. *Pseudapocyrtus catanduanensis* Schultze, female.
25. *Exnothapocyrtus basifasciatus* Heller, male.
26. *Pseudapocyrtus apicatus* Schultze, female.
27. *Apocyrtus inflatus* Erichson.
28. *Pseudapocyrtus formicarius* Heller.
29. *Pseudapocyrtus catanduanensis* Schultze.
30. *Apocyrtus mcgregori* sp. nov., male.
31. *Apocyrtus mcgregori* sp. nov., female.
32. *Exnothapocyrtus cylindricollis* Heller.
33. *Exnothapocyrtus basifasciatus* Heller.
34. *Nothapocyrtus translucidus* Heller.
35. *Macrocyrtus* (*Macrocyrtus*) *nigrans* Pascoe.
36. *Macrocyrtus* (*Macrocyrtus*) *subcostatus* Heller.
37. *Macrocyrtus* (*Exmacrocyrtus*) *ilocanus* Schultze.
38. *Macrocyrtus* (*Exmacrocyrtus*) *erosus* Pascoe.
39. *Macrocyrtus* (*Exmacrocyrtus*) *multipunctatus* Schultze.
40. *Macrocyrtus* (*Exmacrocyrtus*) *trivittatus* Schultze.
41. *Eumacrocyrtus canlaonensis* sp. nov.

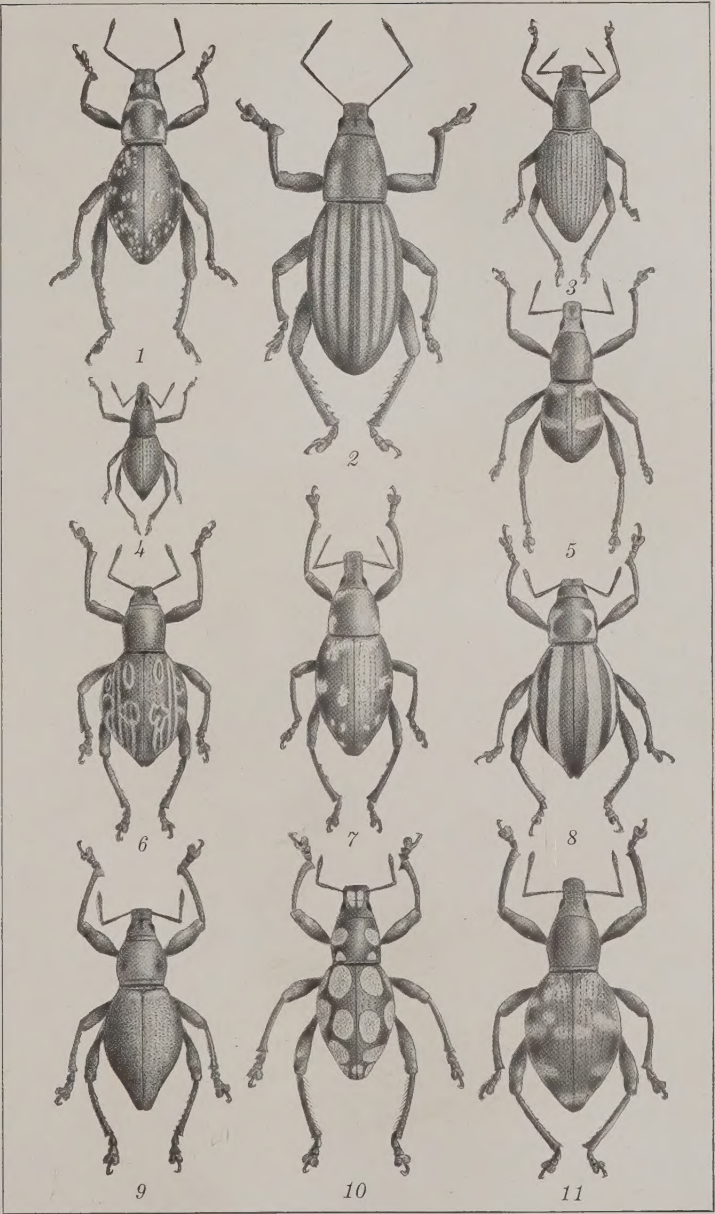


PLATE 1.

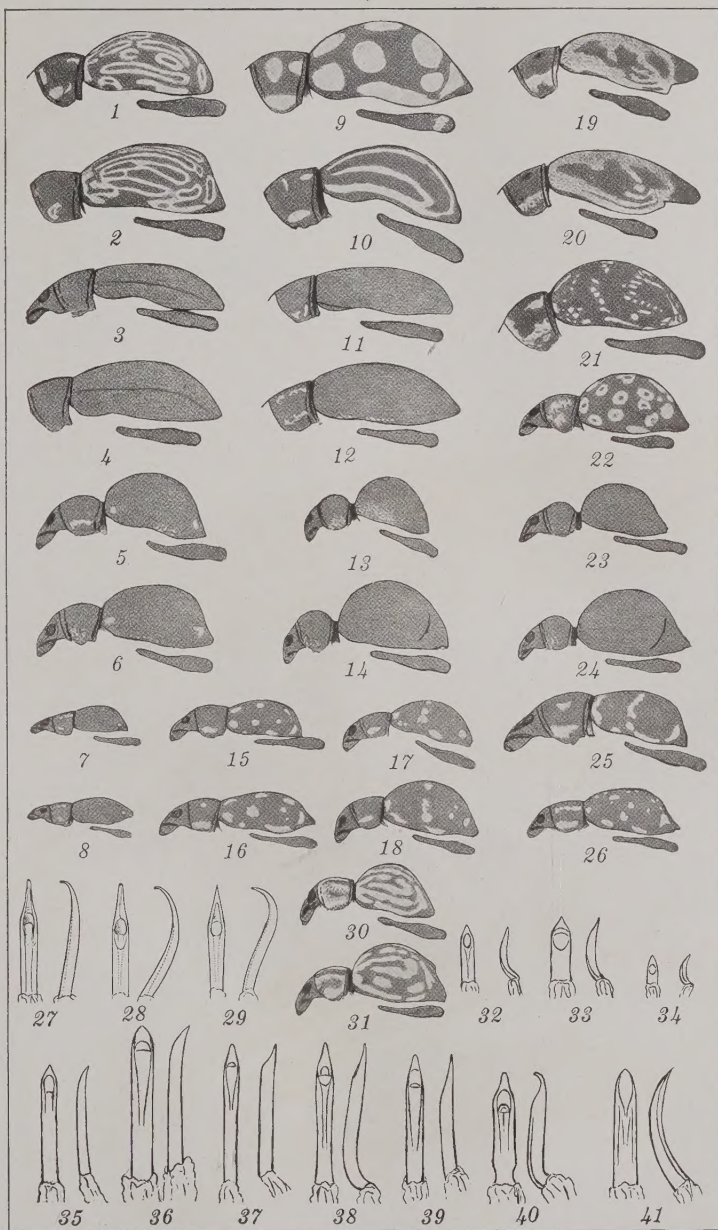


PLATE 2.

